POWER

Established 1884—McGraw-Hill Publishing Company, Inc.
PHILIP W. SWAIN, *Editor*

MARCH, 1934 Volume 78, Number 3

BOTTLE NECK

• THE FLOOD TIDE of recovery is piling up at a bottle neck. Money, and lots of it, is needed to permit modernization of industrial equipment on a large scale. For months POWER has been working at this key log in the economic jam. Its editors have talked with power engineers, manufacturing executives, consultants, power equipment builders, and men in the know at Washington. Here are typical views:

• POWER ENGINEER: "It would pay us mighty well to modernize our power equipment, but owners hesitate—postpone."

• INDUSTRIAL EXECUTIVE: "Our engineer tells us that a modernized plant would save its cost in two years. He may be right, but we haven't the money and the banks won't lend it."

• ORDINARY BANKER: "We can't take the chance. What would our depositors and stockholders say and do if we damaged our liquid position through over-generosity? What value would a power plant have for us if the buyer should fall down on payments?"

• COMMERCIAL CREDIT BANKER: "We'll finance a complete power job provided we get a two-name note for each piece of equipment, signed jointly by the purchaser and the equipment manufacturer."

• POWER - EQUIPMENT MANUFACTURER: "We need the business. Lord knows the user needs the modern equipment if he is to find any profit between the millstones of competitive sales price and code-fixed wage rates. The ordinary banker won't or can't help. The commercial-credit banker is naturally pleased to accept notes jointly guaranteed by us and by user, but where does that leave us? We dare not dip too deeply into our own funds and credit. The only answer is government financing of industrial improvements."

• SELF-FINANCING POWER EQUIPMENT MANUFACTURER: "We answer that by accepting payment for our equipment out of savings."

• CONSULTING ENGINEER: "That is O.K. as far as it goes, but our hands should be free to finance a complete economical power set-up including any makes of equipment we may care to select. The ordinary banks are no help, the commercial-credit groups not much better, because of too many strings on the jobs."

• MAN IN THE WASHINGTON KNOW: "New Deal forces are alive to this problem and working on it right now, but please don't expect the Government to dish out money to all comers without security. Too dangerous; the wrong men will get it! But U. S. may work out some plan involving R.F.C. or Federal Reserve funds plus some joint local responsibility as a safety check."

• POWER SUMS UP and adds its own views: "Easier financing of dollar saving equipment is essential to help industry pay N.R.A. wages and sell at attractive price, to put the breath of life in the capital-goods industries, to keep national recovery in motion. If private or semi-private credit organizations can supply funds on liberal terms that will be best. If this cannot be done immediately, the Government must step in, either directly or as an underwriter of private credit agencies."

STEAM TURBINES "THIRD"

ASK ANY ENGINEER which prime mover is most widely used in central stations. Dollars to doughnuts, his answer will be, "Steam turbines, of course!" Well, he's wrong—from one angle. The latest official count is: 3,785 hydro turbines, 3,276 diesels, 2,821 steam turbines, 1,300 steam engines. Sure, there's a catch. Average hydro turbine capacity is 2,600 kw., diesel around 200 kw, but the average central station steam turbine is good for 8,000 kw. On an installed capacity basis, then, the turbine easily makes the top of the heap with a 35 to 1 advantage over the diesel and 2½ to 1 over the hydro turbine.

BLOWING OFF ABOUT BLOWDOWN

ENGINEERS ARE HUMAN; they like to argue. From the spectator's point of view, an engineering argument is more exciting than the common garden variety of street brawl, because it is spiced with intelligence. For the edification of its readers, *Power* presents such an argument (both sides) on page 132. Briefly, "Must boiler efficiency be penalized for blowdown heat waste?" The able mustering of points by Messrs. Berry and Coleman proves once more that things are not as simple as they seem. The editors would be glad to hear how readers like the idea of sitting in on such debates.

BAROMETER A LA CARTE

MAN IS GRADUALLY LEARNING how to manufacture his own weather. First came heating, then ventilation. Next were air filtration, moistening in winter, dehumidification in summer.

But how about barometer? Heating and ventilating engineers have paid no attention to that, thinking it of no importance. "Not so" is the guess of C. A. Mills, M.D., who had a lot to say about climate at the A.S.H. & V.E. annual meeting in February. To rapid barometric shifts, as well as to wide temperature fluctuations, he lays the good and bad points of northern U. S. weather. He suggests a future when some of the population at least may live, work or undergo medical treatment in air-tight habitations, pressure controlled for any desired barometric conditions: high, low, fluctuating or steady. If and when this happens, the engineer will have one more thing to worry about.

CLEAN CO_2

IT SEEMS TO BE pretty well demonstrated that boiler flue gas is not now a commercially practical raw material for the manufacturer of liquid or solid carbon dioxide. Much purer CO_2, in amounts far exceeding present or anticipated demands, is available as a by-product of fermentation and certain other chemical processors. So far the power engineer has had little luck in attempts to make money out of such by-products as flue gas and ash. But his success with by-product power is phenomenal, so why worry?

CONDENSING

SOME MONTHS AGO, *Power* pointed to the returning popularity of the condensing industrial power plant. Not far back were described the installations in Macy's store (New York) and Newark (N. J.) Evening News plant. Now comes a third recent installation in the same region. American Chicle (page 115) combines non-condensing bleeder turbines with a bleeder condensing unit served by a cooling tower. Granted efficient small turbine units (now available), and a high ratio of power load to process steam load during a large part of the year, this arrangement gives a very low year-round fuel cost for power. It permits maximum generation of by-product power and minimum fuel consumption for the additional power that must be generated by steam passed to condenser.

A REAL JOB

WHY DO PROFESSORS and students of mechanical engineering so persistently overlook plant engineering as a superior mode of living and a field where real talent can find application? Few engineering positions carry greater responsibility than that of plant engineer in a large industrial establishment. None anywhere gives wider opportunity for the application of technical knowledge and judgment. Standing and salary are limited only by size of plant and the man's ability to get things done.

POWER STANDS FOR

1. Making power when it should be made
2. Buying power when it should be bought
3. Cheaper power through modern equipment
4. Easier financing of equipment purchases
5. Better use of by-product heat and power
6. Operating methods that save money
7. Less waste in transmission and application
8. Prevention of smoke, within reason

ADD TURBINES TO BOILER PLANT;

WILL PAY OUT IN 3½ YEARS

American Chicle Company installed a 1,500-kva., steam-turbine-driven, 4-unit power-generating plant and cooling-tower capacity for one 550-hp. unit and its refrigerating plant. Savings in operating cost will return total equipment investment and consulting engineer's fee in about 3.5 years

WHEN the American Chicle Company, Long Island City, N. Y., built its plant in 1920, the relative merits of generating and purchasing power were carefully considered. At that time the estimated savings in favor of installing generating equipment were not considered sufficiently large to justify the investment. It was, therefore, decided to install three 6,000-sq.ft. boilers designed for 200 lb. but to be operated at 150 lb., a 450-ton refrigerating plant driven by steam engines, and to purchase power. It was felt, however, that conditions might change sufficiently in future to make economical the installation of power-generating equipment, so space was provided for this in the building.

A study of power and steam requirements made by the company's engineers in 1931 indicated that much could be saved by generating instead of purchasing power. Percival R. Moses and Associates, New York City, were retained as consulting engineers to make a preliminary survey and report. This survey indicated that such a plant could be installed and would reduce the power cost sufficiently to pay for itself in about three years. The report was accepted, and the consulting engineers were asked to make a more detailed study of the plant.

Engines of the refrigerating plant operated against atmospheric pressure with some use of exhaust for heating boiler feed and water for building use. All process steam was supplied directly at boiler pressure through reducing valves. The refrigerating plant was used only in the summer. In winter, when the demand for low-pressure steam was at its maximum because of building-heating load combined with process, the refrigerating plant was not in service. This made it necessary to supply practically all winter low-pressure steam through reducing valves from the high-pressure line. These low-pressure steam requirements made installation of a power plant appear very favorable, as the exhaust from power-generating units could be used for heating and process and would make the thermal efficiency for power generation very high.

Cooling water for refrigerating-plant condensers was purchased from the city. After going through the condensers, part of the water was used for house-service purposes, and the remainder was discharged to the sewer. It was desirable to save the cost of water then going to the sewer, if it could be done economically.

It was decided to install four steam-turbine-driven generators, one turbine to operate condensing, with a connection for bleeding process steam. A cooling tower was to be installed on the roof of the building. This tower was to be built with a division wall so that one part could be used for the condensing turbine and the other for the ammonia-condenser cooling water. This construction would reduce the initial cost considerably below that for two separate towers.

Other items included in the final plan were several steam flow-meters and changes in piping to utilize exhaust steam for process and water heating. With a very liberal allowance for all cost items, and a conservative estimate of savings, it was estimated that the installation could be made for about $72,000, and that this investment would be returned in less than four years from savings in operating cost.

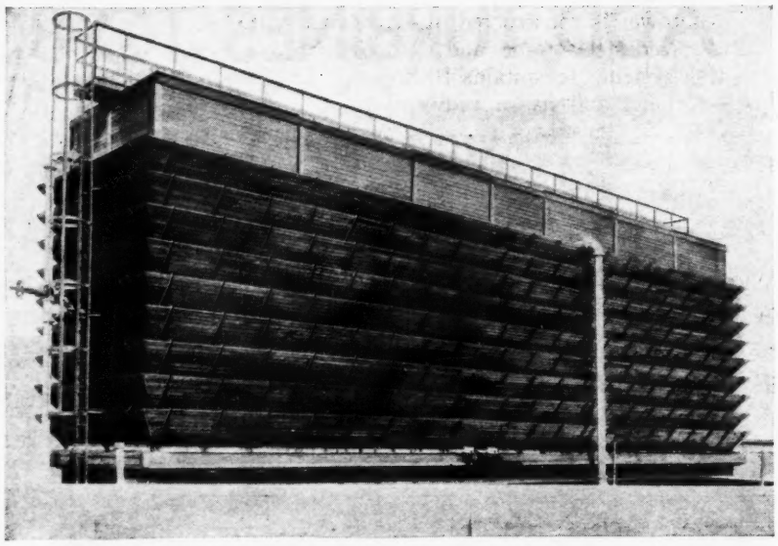
On this basis it was decided to make the installation, which, when completed, would provide a highly efficient steam-and-power generating plant equipped with meters and other facilities so that it could be operated practically under test conditions at all times. In addition, the equipment permitted the operators to keep a comprehensive record of steam-and-power distribution to all services.

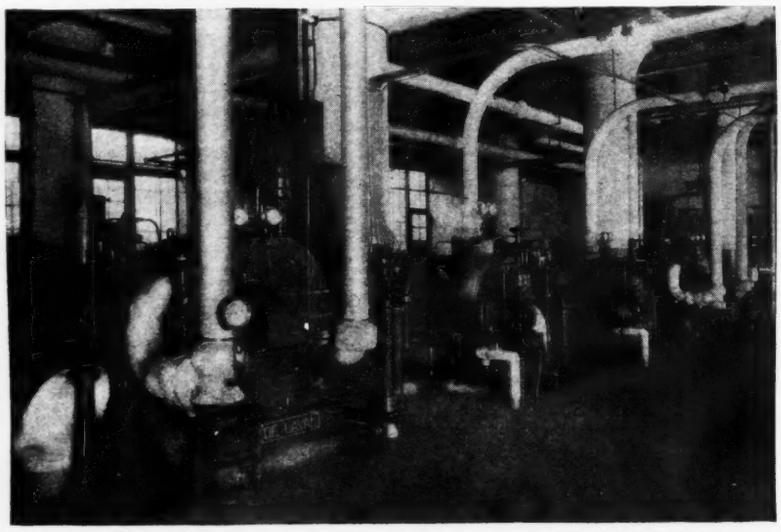
When selecting the power-generating equipment, steam-engine driven generating units, diesel engines, and combinations of steam and diesel engines were considered. For the conditions prevailing in the plant, turbines were found to be the most economical because of their low cost and the large demand for process steam at low and intermediate pressures.

Even though a large part of the exhaust would go to process, a cooling tower would be required to obtain an

approximate heat balance whether turbines or steam engines were installed. Furthermore, if the steam engines were installed, the 35-lb. process steam would have to be supplied through a reducing valve. With a turbine installation, this steam could be bled from one of the units after giving up part of its heat in the turbines for power generation.

The combination of units decided upon was selected so that it would be sufficiently flexible to meet all load and service requirements efficiently, and be independent of purchased power, with the exception of a small connection for emergency lighting. Two of the units have 550-hp., 4,700-r.p.m., geared turbines driving 500-kva., 1,200-r.p.m. generators. One of these turbines operates condensing and is designed to bleed a maximum of 6,000 lb. of steam per hour at 35 lb. gage, through an automatically controlled bleeder valve. The other 550-hp. unit is a non-condensing bleeder machine of the same general design as the condensing machine. A third unit is a straight, non-condensing 335-hp. turbine geared to a 312-kva. generator. The fourth unit, for night service, is a 200-hp. turbine geared to a 187-kva. generator. All these generators are designed for 7,200 volts, 3-phase, and 70 per cent power factor. The turbines and gears are De Laval, one exhausting to a Foster Wheeler surface condenser, and the generators are Crocker-Wheeler with direct-connected exciters.





Top—This cooling tower serves the ammonia condensers on refrigerating machines and the condensing turbine. Above—Three turbines operate non-condensing and one condensing

The condensing turbine is designed to operate in connection with a Foster Wheeler open-draft cooling tower and a surface condenser to maintain a 27-in. vacuum. This turbine has five stages, the non-condensing bleeder unit has four stages, and the other two are of standard design.

Under normal full-load winter conditions, the turbine-generators operate in parallel and divide the load in such a way that as much power as possible will be generated as a by-product of process steam and will therefore be produced at the highest thermal efficiency, the remainder of the load being supplied by the condensing unit. In summer there is an excess of exhaust, and as much of the load as possible is carried on the condensing unit. The entire night load is carried by the small single-stage unit.

The condenser is a 3-pass steel-shell design with Muntz metal tubes and tube sheets. The tubes are rolled into both sheets; expansion and contraction are taken care of by an expansion joint in the shell. It has 765 sq.ft. of tube surface and provides a vacuum of 27.17 in., with 85-deg. cooling water. Condensate is removed from the hotwell at a temperature of 113 deg. F. by a hotwell pump designed especially for operating with small submergence, which in this case is less than 1 ft. This pump is also designed with only one sealing gland, which is on the pressure side of the pump to eliminate air leakage into the pump. Non-condensible vapors are cooled by an internal air cooler and are exhausted from the condenser by a two-stage steam-jet air pump.

As previously mentioned, an atmospheric-draft cooling tower is provided. This tower is arranged in two sections so that one will cool water for the air-conditioning-system ammonia condensers, and the other section will handle circulating water for the turbine condenser. This method of operation was decided upon because the periods of operating of the two classes of equipment do not coincide, even in summer, and in winter the air-conditioning system is shut down. The temperature of the cooling water for the two services is also different.

Discharge piping to the tower has been arranged so that the whole tower may be used, or just the lower

half. This tower is constructed of California redwood on a galvanized steel frame, and is fitted with a spray distribution system. It contains 10 decks, is 12 ft. wide and 70 ft. long, and has a redwood basin under its entire area. The steam-condenser section of the tower under normal summer conditions cools 600 gal. of water per minute, and the ammonia-condenser section cools 1,050 gal. under extreme summer conditions.

Neither section of the tower has sufficient capacity to take care of maximum-load conditions at all times. It is expected that there will be a few short periods in each year when it will be necessary to add some water from the city main to assist in cooling circulating water. When selecting the tower, an effort was made to obtain the most economical balance between investment in cooling-tower capacity and make-up water allowed to run to waste.

7,200-Volt Generators

The generators, for units of their size, are somewhat unusual, because of the high-voltage, 7,200, for which they are designed. Power was purchased and metered at 13,200 volts, 3 phase, and stepped down to 220 volts 2 phase through two banks of Scott-connected power transformers some distance from the present powerhouse. These transformers and the high-voltage distribution system in the building are owned by the American Chicle Company. When selecting a generator voltage, 220 volts was carefully considered, but it was found that by going to 7,200 volts, a voltage for which the transformers could easily be adapted, over $5,000 in installation cost could be saved.

The plant is equipped with meters so that it can be operated practically under test conditions, and all essential quantities are metered to the different services. Coal is delivered to an overhead bunker and is weighed to each boiler by a power-operated larry. Water is metered to the boilers, and steam output is also metered.

Orifices are placed in the main line that carries steam to the turbines and in the individual lines to each turbine. Connections from these orifices are brought to two manifolds that connect to a meter body and a flowmeter and integrator. By suitable valves, any one of these orifices may be connected to the flowmeter. Normally, total steam to the turbines is metered, but if it is desired to check steam consumption of any one turbine, this machine is connected to the meter, and steam to the others can be estimated from water-rate and kilowatt curves.

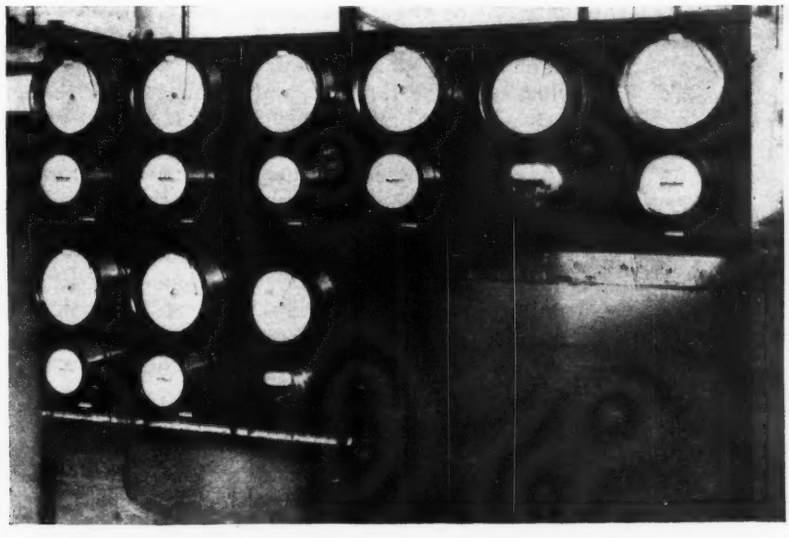
Steam to the ammonia compressors, all other principal services, and to the tenants, is metered. Several of the minor services of steam are estimated, and a correction factor applied to account for all steam used in each month. Power generated and supplied to all essential uses is metered; the minor quantities are estimated, based upon tests to determine the relation between amount of production and power used. A correction factor is also applied to the estimate. Estimates for both steam and power are fairly accurate, as the correction factor is generally within the limits of 5 per cent. Daily checks are made of operation, and any unusual variations from normal investigated and corrected if necessary. From the daily report, detailed monthly reports of operation and cost of production are compiled and carefully studied for anything unusual.

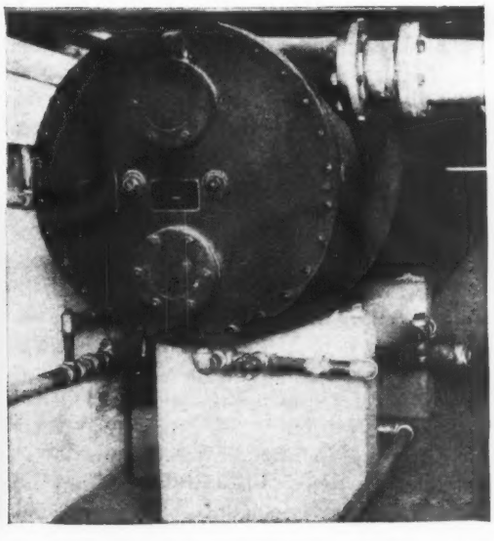
Power at Half Price

The plant has been in operation since May, 1933, so that opportunity has not been had to determine the full economy of conditions existing in the heating season. However, from present figures, after all charges have been made against the power-generating facilities, including depreciation, interest, insurance, rent and administration, power is generated at about one-half the former purchase price. The savings in cost of power and water will pay the total investment for the installation in approximately four years, and are well over the estimates. When the additional saving obtained by winter operation is considered, this time will be further reduced.

Power is indebted to C. E. deVivo, plant engineer, for assistance in the preparation of this article. Operation of the power plant is under the supervision of P. Koenig, chief engineer.

Left—Steam for all important services is metered by these steam flowmeters. Right—Surface condenser on the 550-hp. turbine is of 3-pass design with 765 sq.ft. of tube surface





WHEN and WHY

BOILERS ARE SAFE

Past president of the A.S.M.E., a leader in its Boiler Code work, Dr. Jacobus has long been recognized as a master of the art of boiler design and construction. These practical comments are a condensation of his recent paper before the Engineers Club of Philadelphia

NO term is as much misused as so-called "factor of safety." In the case of a boiler drum, factor of safety, as ordinarily defined, is the ratio of the ultimate strength of the material to the stresses caused by steam pressure. Where there are tube or rivet holes or the like, the average stress in the ligaments between the holes is used. No account is taken of the stress concentration at the sides of the holes, where stress may be more than twice as great as the average stress in the ligaments or of other elements, so that the factor obtained is far from being a factor of safety in showing the ratio of the strength of the material forming the drum to the maximum stress in any portion of the drum.

What are usually known as "factors of safety" are in reality design factors which in most cases have been arrived at through long experience in actual construction.

The A.S.M.E. Power Boiler Code provides for a so-called factor of safety of 5. This factor involves many elements. Study of these shows that the factor is far from being a measure of the safety and that it is considerably higher than the true factor of safety.

More and more attention is being given to stress concentration. The ductility called for in the specifications for steel plate for boiler construction provides a safety element in reducing stress concentration by allowing redistribution of the stresses in the metal at any point where the proportional limit is exceeded.

About five years ago, results were published for the stresses that produce creep in steel when subjected to high temperatures. These caused apprehension on the part of many engineers, and led to a paper entitled, "Working Stresses for Steel at High Temperatures," which I presented at the annual meeting of the American Society of Mechanical Engineers in December, 1929. The stresses in this paper were based on results secured in practice and were rationalized by employing certain creep values given in tests that had been made by Mr. French of the Bureau of Standards. It was emphasized in the paper that the working stresses given were those suitable for boiler drums, pressure vessels and superheater headers constructed of plain carbon steel and that different values should be used for other types of service and other kinds of materials.

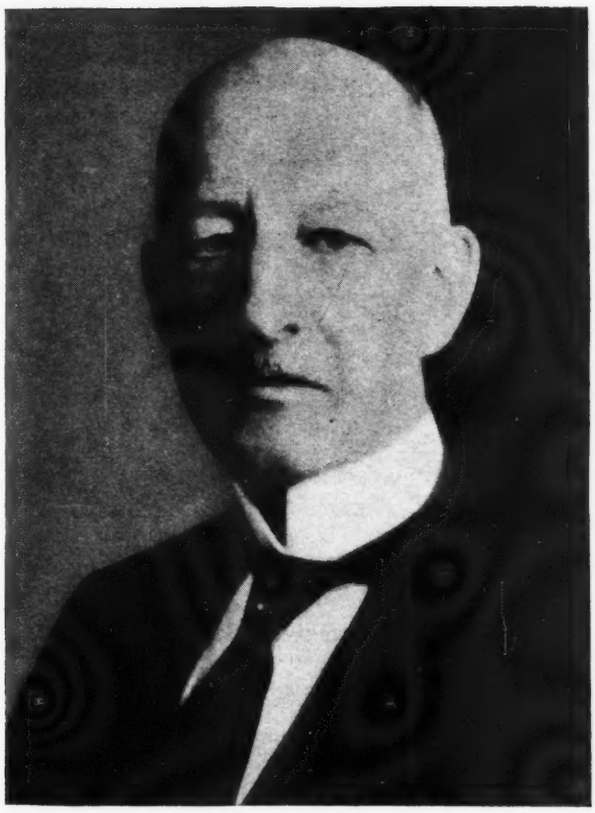
The values now given in the A.S.M.E. Boiler Code are based on those published in that paper. That the values may have to be modified for different types of service is shown in the work of the Joint API-ASME Committee on Unfired Pressure Vessels for Petroleum Products, where higher allowable stress values are proposed in a preliminary report.

Another cause of apprehension has been the so-called "caustic embrittlement," about which there are still some differences of opinion. This action occurs with certain feed waters where caustic soda is present in the absence of certain other elements. Cracks of a peculiar form occur in the shell plate, particularly at riveted seams below the water line. The cracks are, in general, intercrystalline, although in certain cases, after having been started through a caustic action, they may extend through the body of some of the crystals.

Although this phenomenon occurs only in stressed material, the cracks do not follow the lines of maximum stress and sometimes run past each other and around parts or islands in the plate. Fortunately, leakage usually occurs to such an extent that it serves as a warning before a drum explodes. Another warning is the dropping off of rivet heads, which usually takes place on the inside of the drum, the heads being found detached on making an inspection, or being readily broken off when struck by the inspector's hammer.

Much work has been done by The Babcock & Wilcox Company in investigating this subject, which started in the early days long before the theory of caustic embrittlement was evolved. It was claimed that the cracking might have come from poor workmanship rather than from the feed water. A vast amount of service data was collected. This, together with much laboratory research, led to the conclusion that the action might be inhibited by maintaining certain ratios of sodium sulphate to total sodium hydroxide and sodium carbonate alkalinity.

About ten years ago, these data were presented by H. J. Kerr of The Babcock & Wilcox to the Subcommittee of the Boiler Code Committee on Care of Steam Boilers and Other Pressure Vessels in Service, and



By D. S. JACOBUS
Advisory Engineer,
The Babcock & Wilcox Co.

ratios of sodium sulphate to total sodium carbonate alkalinity which he suggested were embodied in the Rules for the Care of Power Boilers which form Section VII of the A.S.M.E. Boiler Code. No difficulty has been experienced where these ratios have been followed, and up to the present time there appears to be no reason why the ratios should be changed.

There are some differences of opinion about this theory, but the fact nevertheless remains that there is a vast amount of cracking of this kind being discovered which warrants the taking of definite steps to prevent it. The only constructive suggestion that has been presented so far is the one just outlined. It is certainly much better to apply the best known remedies than not to take any precautions at all simply because one doesn't agree with the theory. There are undoubtedly many undiscovered cases, as is evidenced by the fact that disastrous explosions have occasionally occurred.

Where there is indication of caustic embrittlement, examination of the inside of the rivet holes may reveal the characteristic cracks. The Hartford Steam Boiler Inspection & Insurance Company has developed a microscope for examining and for photographing these cracks. In the past few years, that company's inspectors have discovered over 500 cases of caustic trouble, and I am told more are constantly being found.

The experiments made by Dr. D. J. McAdams, Jr., on the Corrosion Fatigue of Steel show that this action should be considered, particularly in connection with the use of steels of higher tensile strength. Care in maintaining proper alkalinity of the feed water to render it non-corrosive would prevent the action, as far as is indicated by any data now available.

All these things are cited to emphasize the number of elements that must be considered in formulating rules for the safe construction of boilers. Progress should be made on the basis of scientific data and facts. It was considered best by the Boiler Code Committee to provide broad rules, amply safe, rather than to sanction hair-splitting factors likely to give trouble.

The art of boiler construction has been carried to a point at which, under proper operation and good inspection, there is little or no chance of an accident. Indeed, the records of accidents to boilers in the past ten or fifteen years are positive evidence that latter-day standards have brought about a high degree of safety. Few, if any, accidents are due to structural weaknesses inherent in the design, workmanship or material used. Also, the use of the much criticized factor of safety has contributed to the long life of boilers by delaying the approach to the danger point because of various deteriorating influences.

Other chances of accident in a power plant outweigh those in a boiler; for example, in the burning of gaseous, liquid or pulverized fuel there may be and have been explosions in the furnace, with disastrous results. This subject warrants special attention on the part of the power-plant operators. Of the three kinds of fuel mentioned, natural gas is probably the most dangerous. In localities where this gas is available as a fuel (and these localities are being rapidly extended), several bad explosions have occurred.

Recently, a gas explosion occurred under a brand-new boiler being fired for the first time. The entire setting was blown down and the building considerably damaged, but the boiler itself was not injured in any way. One man was killed and three were seriously injured. Repairs cost more than $20,000. The case is cited to illustrate the need for extraordinary care in manipulating furnaces using any of the three fuels mentioned above. Indeed, I might take occasion at this point to stress the imperative need of employing only high-class men and training them in great detail with the duties entrusted to them. This applies, of course, throughout the whole power plant.

Regulations of the National Board of Fire Underwriters for the Installation of Pulverized Fuel Systems provide safety elements which are the result of long experience and the careful work on the part of capable engineers. In many cases, however, these rules are not followed as closely as they should be.

Unfired pressure vessels in the power plant should be carefully built and maintained. Only regular and frequent inspections can prevent occasional failures. There is a tendency to neglect such apparently inconsequential pieces of apparatus, but, if uncared for, they are potential hazards.

ENGINEER COOKE COOKS SALMON

The Tearful Tale of a Fish Chef in America's Ice Box

By S. H. COOKE
Steam Engineer

NINETY-NINE out of a hundred citizens believe that salmon is cooked before it is canned. I'm the hundredth, for I've been a salmon chef North of 53 for the past twenty years—in other words, for a steam engineer, I do a lot of cooking. The process goes about like this: Cans of raw fish, seamed lightly on the machine lines, are loaded into steel trays on trucks which are then pushed along a track into boiler-like steam retorts, the open ends of which clamp tight after they are loaded.

The retort attendant turns on steam, raising the temperature to 240 deg. F. and holding it there for an hour and a half. It's a simple enough job, but in my twenty years I've been there when two explosions occurred. One was due to a leaky expansion tube and strained rack-and-quadrant in the retort pressure gage, plus a jammed safety valve. The attendant, watching the bum gage carefully, finally got full 140 lb. boiler pressure on the frail retort shell, which of course isn't supported by bracing or boiler tubes. It blew—and wrecked that end of the plant, to say nothing of the attendant.

In another instance, the attendant left his station at the retorts, with a valve cracked open and pressure steadily rising. He went away too far and stayed away too long! The front end casting and door were torn from the shell rivets and passed me on their way out of the end of the cannery. Was my face RED!

Was my face RED!

Possibly the greatest engineering mystery North of 53, at least the greatest I've heard about, also concerned a retort. In laying up the cannery for the season the retorts are washed and painted. A little steam was turned in to dry them thoroughly before painting, the doors were closed and all valves shut off. Suddenly the retort collapsed like an eggshell! I believe the condensing steam set up a vacuum within the retort and atmospheric pressure crushed the walls. Have you a better explanation?

Steam engineers may be interested in a few notes culled from my operating diary:

"All cannery engineers work a 6-hour day—six hours *after* supper."

"The foreman says I have as much chance of getting a 300-gal. settling tank for the boiler room (with cleanout to remove fuel-oil sludge) as Will Rogers has of being elected President of the United States."

"Main cylinder head flies into fragments. I'll whittle a new one out of oak planking. This boy Robinson Crusoe was pretty ingenious, too!"

"I've worn out two pairs of shoes filling 1-pint engine lubricators. President Roosevelt ought, under the New Deal, to make it compulsory to supply engineers with quart lubricators."

Under the cannery—

"Just asked the bookkeeper for four cross-over tees, four double-branch ells, two side-outlet ells and a single-sweep tee. Now he wants to know if I want to order any pipe fittings on the next southbound mailboat."

"Put through 6,000 cases of salmon today at a fuel cost of 2 cents a case. Average fuel-oil cost on 130,000 cases stands at 1.4 cents per case."

"Side firebricks fall in at noon; boiler front arches drop at supper time. What a life."

"This rigid economy! Wouldn't let me put galvanized iron under the ashpit brickwork and floor this spring. Cannery floor catches fire. I play fire chief, swimming under the building with a lifebelt and a fire extinguisher."

"Fuel-oil pumps race. Strain governor diaphragm throttling the pump. Screens blocked on pump intake and discharge. Spares are ready. Fireman drops them through the floor. Lose pressure and flame. Bookkeeper relieves me for lunch. Monkeys with the valve. Has a backfire. Loses his flame, eyebrows and Chaplin lip fuzz. He says all engineers are So-and-So's."

He prayed for rain

"Water reservoir empty. Pull boiler fires. Manager prays for

rain. Lord receives his message."

"Pinhole leaks develop in the old main steam line. Manager suggests a concrete covering. Told him that he was probably drunk when he read that in the wrong book."

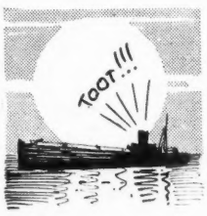
It wasn't clogged

"Foreman places the fuel nozzle of the fish-house oil engine to his face and depresses the 700-lb. fuel-pump operating lever to prove the nozzle is stuffed up. It isn't and his face isn't red."

"Ask storekeeper to order some machinist's bluing—I've got some high spots in bearings I want to scrape down. He says that engineers must supply their own laundry materials! Now I'm afraid to ask him for soapstone marking sticks."

"Semi-diesel heads should be kept to a temperature around 140 deg. F. John forgets to open up the water service until too late, then shoots cold water into the hot head casting. Another cracked cylinder head to weld up tonight instead of going to bed."

"Watchman has electric lighting engine turning up 638 instead of 525 r.p.m. Switchboard registers 113 instead of 110 volts. Says things have been running that way nigh on twenty years. Bad habits sure die hard!"



Not until bedtime

"After the third new set of bearings, the bookkeeper finally is convinced that a full oil sump does really prevent burn-out of lower engine bearings while charging radio batteries."

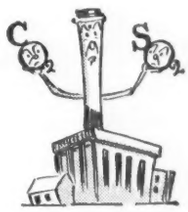
"These fuel-oil cargo boats never whistle for us until it's time to go to bed. Another sleepless night. Good night!"

WHAT TO DO WITH SO_2 AND CO_2 FROM FLUE GAS

PRESENT-DAY demands for purity of air in large industrialized communities have been responsible for the installation of expensive dust-removal equipment by large central steam and power stations. CO_2, in the form of liquid or solids, has seemed a possible source of revenue if removed; sulphur dioxide presents a definite danger if not removed. Realizing these things, the Power Division of the A.S.M.E. Metropolitan Section asked for two papers from chemical engineers. They were presented at a meeting Feb. 7, and the outlook, in both cases, isn't too bright.

C. E. Scott, discussing "Removal of Sulphur Dioxide in Flue Gas," pointed out that *all* flue gas from a power plant must be treated to remove SO_2. This immediately sets up a difficult problem. (A. R. Mumford, chairman of the meeting, in discussion, brought out that to remove the SO_2 from the flue gas of one 100-ton-per-hr. power plant would require something like 1,300 wetted-wall towers, $3\frac{1}{2}$ ft. in diameter and 26 ft. high!)

Varying conditions of gas flow and varying SO_2 concentrations in the gas make it difficult to provide a design flexible enough to operate at maximum efficiency over the entire range. It is not impossible, but it presents considerable difficulty. Battersea station in England included SO_2 removal in its design, and as mentioned in *Power* (Sept., 1933) the cost for this equipment alone was more than a million dollars. This is the largest experimental air-purifying installation ever built. These experiments have given some interesting results. Using cold water, best sulphur elimination was found to be 76 per cent. However, experiments with dilute alkalis gave these results: an 0.25 per cent soda ash solution gave an elimination of 95 per cent, an 0.25 per cent calcium carbonate solution gave an elimination of 92 per cent, and an 0.2 per cent lime solution gave an exceptionally good elimination of 97 per cent. Cost of power and materials when operating with lime is reported to be equivalent to 6 cents (English) per ton of coal burned. The small amount of sulphur dioxide that is not removed in the flue gas is disposed of by exhausting with the residual gases to the stack.



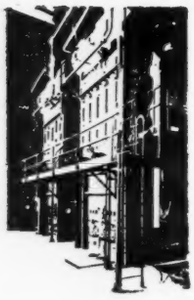
What to do?

It has been found that an atmosphere containing about six parts of sulphur dioxide per million parts of air is obnoxious. If a power station were evolving gases to the extent that a concentration of ten parts per million of SO_2 was found in the neighborhood air, and then a gas washer of 70 per cent efficiency was installed, the surrounding air would not be obnoxious as a concentration of about three parts per million would result.

If a high absorption efficiency is obtained and at the same time the residual gases are diluted sufficiently, no trouble should be encountered due to SO_2. The key to the situation appears to be a good absorption tower, which may be very expensive, plus a high stack for disposal of the residual gas.

Another problem is what to do with sulphur dioxide effluent from the absorption tower. To determine if the market can be supplied with sulphur dioxide, or oxidized forms and salts of sulphur dioxide, is a complicated economic problem in itself.

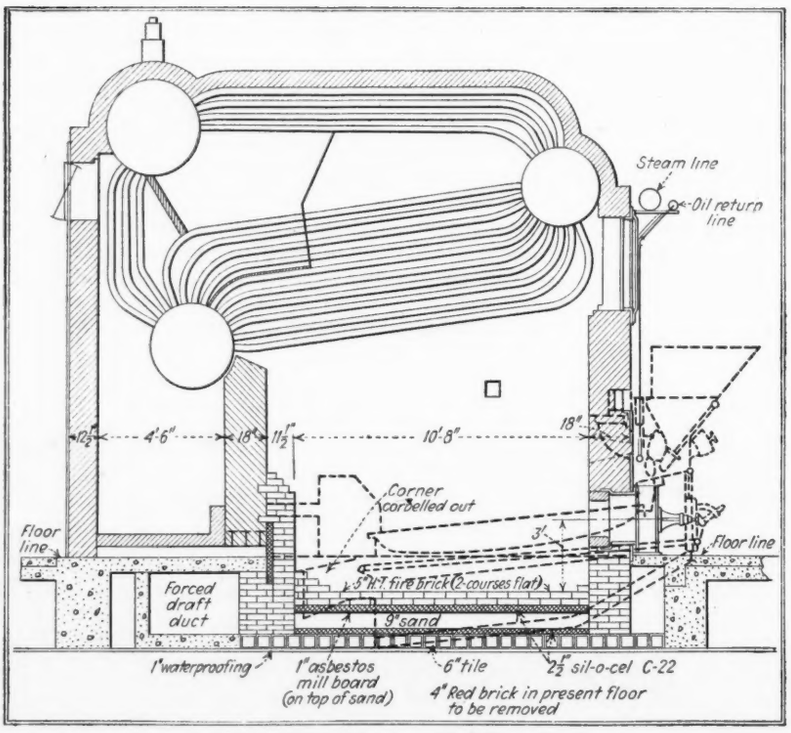
D. H. Killefer, chemical engineer, presented the other paper, on "Recovery of Carbon Dioxide from Flue Gas." He explained that CO_2 is a costless raw material, the only cost connected with its use being that required to put it in usable form. On this basis, the market today does not justify utilizing such secondary sources as flue gas. The market for solid CO_2, the familiar "dry ice" of commerce, was 43,000 tons in 1931, the latest year for which figures are available, and that for liquid CO_2 in the same year was about the same amount. Thus, one power plant, burning 75 tons of coal per day—a figure exceeded each hour by many central stations—could produce enough CO_2 in a year to meet the demand for the entire country! Unless demand is built up to at-present-undreamed-of figures, the reclamation of CO_2 from flue gas isn't commercially practicable. Other sources, such as lime kilns, brewing, and various other chemical processes produce CO_2 that is practically pure.



WESTERN UNION'S SHIFT TO OIL FIRING

WILL PAY OUT IN TWO YEARS

Many a power plant has saved money by maintaining freedom of fuel choice. Here's a new example:



Dotted lines show setting and stoker before change to oil

WHEN the boiler plant of the Western Union Building, New York City, was being designed, coal was the most economical fuel. Consequently, the boilers were fitted with over-feed stokers designed for firing No. 2 buckwheat. The engineers, however, felt that a change to oil might some day pay, so space was left for storage tanks. Opportunity came quickly; in the fall of 1932, three of the four boilers were changed over to oil firing to take advantage of new price relations more favorable to oil.

One year's operation with oil has shown savings sufficient to pay for the cost of the change within two years.

When coal was used, 6,000 tons were burned yearly, with an average evaporation of 9.47 lb. of steam per pound of coal. An average evaporation of 14.92 lb. of steam per pound of oil is now being obtained, so that for equivalent steam generation, the oil consumption is approximately 950,000 gal. per year. Coal costs an average of $5.15 per ton, oil 3¼ cents per gal. In addition to the saving in cost of fuel, the plant has been operated with considerably less labor than was required with coal.

The plant went into operation with four 4,000-sq. ft., low-head, bent-tube boilers equipped with over-feed stokers, as shown by the dotted lines in the diagram. Coal was stored in 300-ton concrete bunkers arranged so that small handcars could be run under them and loaded. A traveling hoist was provided for lifting the cars to the level of the stoker hoppers, into which the coal was dumped as required. Before hoisting, the cars were run onto scales so that an accurate record of daily coal consumption could be kept. Boiler meters and draft gages gave a record of steam output and aided in plant operation. Two fans provided forced draft for the stokers through a duct under the rear of the boilers.

Steam is used for building heating, a cafeteria and domestic hot water. In addition, the boilers must at all times be ready to serve a 250-kw. emergency turbine-generator, which is held in reserve to supply Western Union telegraph load in case central station power is cut off. For this reason the boilers are operated at 85 lb. pressure, although they normally would be required to supply only low-pressure steam not in excess of 40 lb.

The change to oil firing involved installation of oil storage tanks, oil pumps, oil heaters, oil piping, control equipment, removal of the stokers and changes to the boiler settings. In the concreted space provided in the basement, three rectangular oil storage tanks, each of about 16,500-gal. capacity, were constructed, providing a total storage of 49,500 gal. These tanks had, of course, to be built in place.

To install the oil burners, the stokers and grates

were first removed. The front wall previously occupied by the stoker was then built up and three mechanical-atomizing burners installed in them. The burners are 3 ft. from the furnace bottom, and the end burners are 2 ft. 9 in. from the side walls. These distances have proved ample to prevent impingement against the furnace refractory. The shortest distance from the boiler heating surface to the burners is about 7½ ft. Even at peak loads combustion is complete before the boiler tubes are reached.

Furnace Volume Increased

The bridge wall was removed and a new wall built up to the mud drum, thus increasing furnace volume to about 3 cu.ft. per 10 sq.ft. of boiler heating surface. Furnace door openings were filled in loosely with fire brick and peep holes put in for observing oil-burner operation. No change in boiler baffling was necessary.

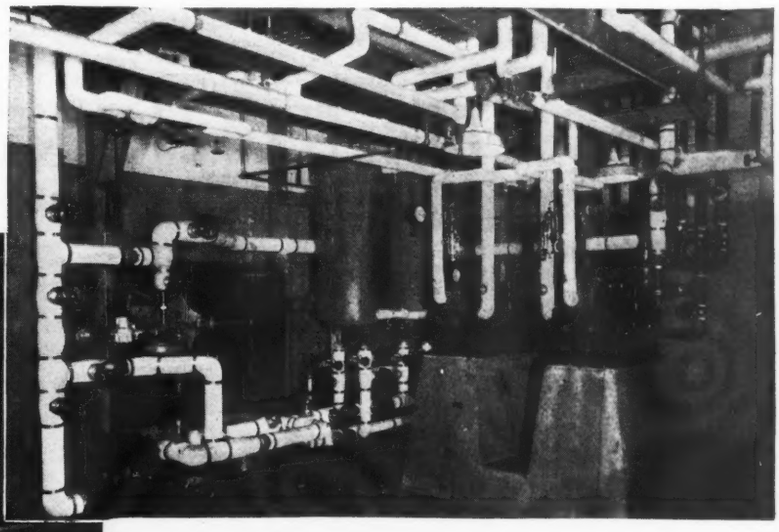
Additional protection was given to the furnace floor. The red brick that formed the surface of the ash pit was removed, 9 in. of sand put on top of the old insulation and tile, 1-in. asbestos mill board on top of the sand, 2½ in. of insulating brick on top of the mill board and finally two courses of high-temperature refractory brick laid flat. Ventilation was provided in the original ash-pit floor, air being taken in through openings at the boiler room floor on one side of the boilers and discharged on the other side through stacks about 6 ft. high.

Bunker C oil is supplied at 125 lb. pressure by either of two steam-driven duplex oil pumps. Oil is first pumped through either of two steam heaters, which raise its temperature to 220-235 deg. It is then metered and delivered to the boilers through a loop header from which each burner is supplied. Thus, should a leak occur on one side of the loop, the burners can be supplied through the other leg while the leak is repaired. Strainers are provided for each burner in the suction line ahead of the pump and in the discharge line ahead of the oil meter. Clean-out pockets are provided at various points in the piping. Meter, strainers, oil heaters and pumps are all bypassed so that a breakdown of any of this equipment will not interfere with the supply of oil to the burners.

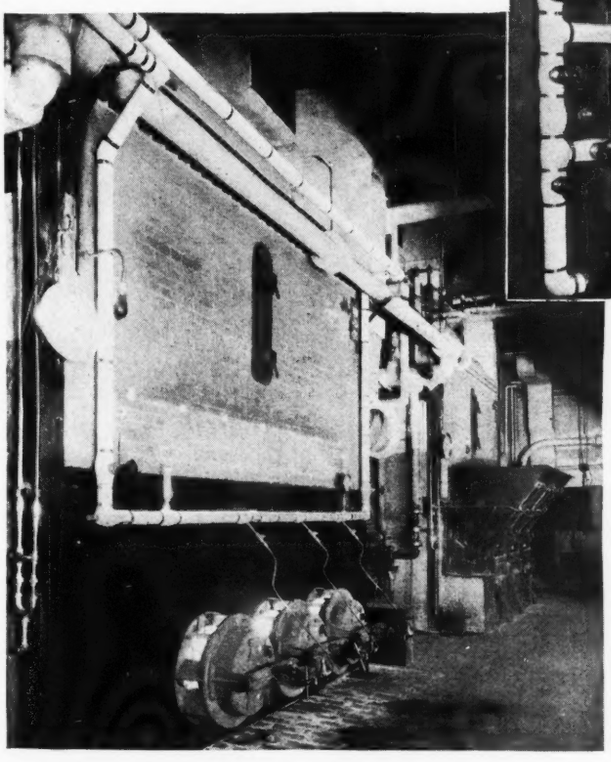
Separate Suction Lines

Separate high- and low-suction lines are provided for each oil storage tank. These terminate in two suction manifolds at the pump, one for the high-suction line and one for the low-suction line. At the tank end, the high-suction line terminates 6 in. above the tank bottom, the low-suction line 2½ in. above the tank bottom. Suction piping at the pumps is arranged so that one pump can operate on the low-suction line while the other uses the high-suction line. Likewise, one pump can empty a storage tank while the other is supplying oil to the burners. The entire oil piping system was designed for maximum flexibility and reliability.

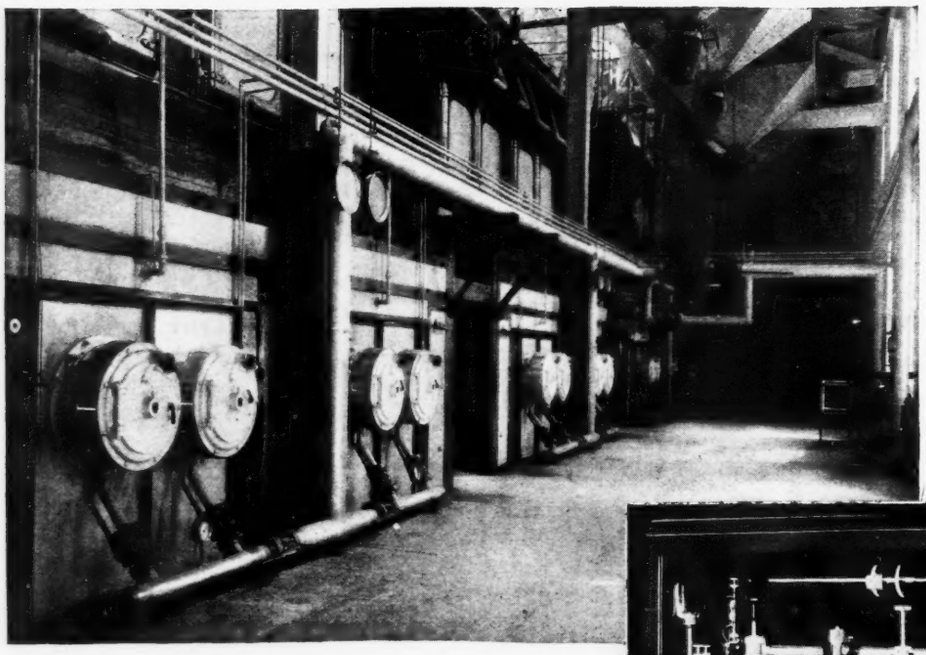
Right—The two suction headers are on the wall in back of the pumps, the two oil heaters on the side wall

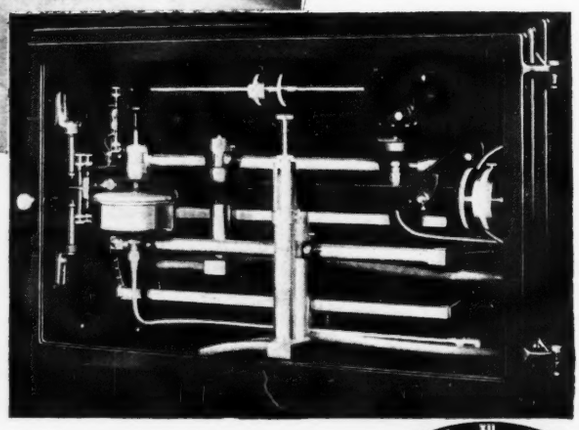


Below—Stokers, as shown on the last boiler, were replaced by Bethlehem-Dahl oil burners



The steam requirements under severe winter conditions have been about 45,000 lb. per hr. To this must be added a possible demand of 12,000 lb. per hr. for the 250-kw. emergency turbine, which exhausts to a low-pressure header or to atmosphere. With oil the boilers have to date evaporated a maximum of 20,000 lb. of steam per hr. each, and it is felt much higher ratings could be carried if necessary. Normally, three boilers are operated during severe winter weather. With coal firing the maximum steaming capacity of each boiler was about 16,000 lb. per hr. The one boiler not changed over from coal to oil is nearest the coal bunker and is kept ready for service should an emergency arise.





Gas replaced coal under the eight 2,600-sq.ft. boilers of Holly Sugar Co., Sidney, Mont. The charts tell the story of close control in spite of wide load fluctuations

FLEXIBLE GAS FIRING FOLLOWS LOAD FLUCTUATIONS

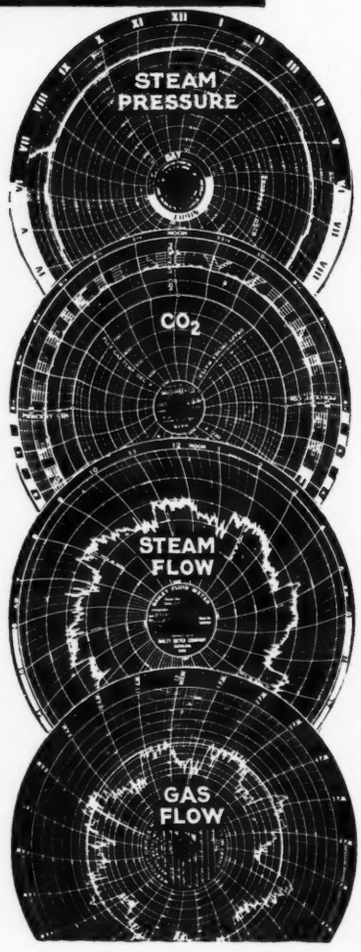
HOLLY SUGAR CO., Sidney, Mont., has recently converted its boiler plant from coal to natural gas. The plant consists of eight 2,600-sq.ft., water-tube boilers without superheaters, economizers or preheaters, set in one line in batteries of two. Four are B & W straight-tube type and four, 4-drum, bent-tube, Stirling type.

Each boiler furnace has two natural-draft combination gas and steam-atomizing oil burners. Since oil is used only as standby fuel, oil burner nozzles normally are hung on convenient racks. Steam is generated at 155 lb. gage. Because it is for both power and process, fluctuations in demand are rapid and vary over a wide range, maximum demand being about 110,000 lb. and minimum 60,000 lb. of steam per hr. Since load is normally carried on seven boilers (one in reserve), peak load is equivalent to 175 per cent of rating. At times, load is carried on six boilers, thus making the peak equivalent to 205 per cent of rating. Combined boiler and furnace efficiency is about 78 per cent.

Gas, from the meter house of Montana Dakota Power Co. at 25 lb. gage, is reduced by the boiler-room pilot-operated regulator to 4½ lb. It is then piped through a motorized fuel-control valve to a header across the boiler fronts. Burner manifolds are connected to this header. The pressure regulator and motorized fuel valves are bypassed, and a manually operated fuel valve is installed in the by-pass around the motorized valve. Shut-off valves are provided for each burner manifold as well as for each burner, lubricated plug cocks being used throughout.

Standby oil-burning equipment includes a 4,000-bbl. vertical storage tank with steam-heating coils. Oil is pumped by an electrically driven gear pump from this tank to a heater in the boiler room, then to the burners, and recirculated to the tank. All lines for atomizing and heating the oil parallel the gas lines and are supported on the same brackets. This arrangement presents a neat, pleasing appearance.

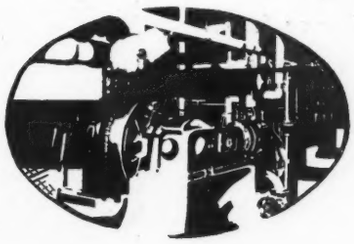
Automatic combustion control in this installation (lower photograph) proportions fuel input to steam demand, maintaining steam pressure constant within close limits. At the same time it maintains excess air within the boiler furnace constant and at the lowest point consistent with the condition of the boiler settings (See charts). It controls fuel input by balancing gas pressure in the burner manifold with steam pressure in the bolier by means of the motorized gas valve. It proportions fuel and air by balancing furnace draft against gas pressure in the burner header. This is done by controlling an electrical mechanism operating one large damper in the flue between the common breeching and stack. It of course automatically compensates for variations in stack draft due to changes of temperature.



OLD CORLISS

RUNS WITHOUT STEAM

By L. W. HAYWARD
Power Superintendent,
Tennessee Copper Co.



WE CHANGED recently from blowing engines to electrically driven turbo-blowers. We had already changed over the blowers which supplied air at 14 lb. pressure for the copper converter, but had still to operate the boiler plant, with full crew, only to supply steam for the blowers which supplied 50-oz. air for our blast furnace.

A motor-driven compound air compressor supplied 120-lb. air for general plant use. This compressor, with maximum capacity of 2,400 c.f.m., was at the time supplying but 500 c.f.m. for the plant, so 1,900 c.f.m. was available for other use. If this could be used to drive the blast-furnace blowing engine temporarily, we could shut the boiler plant down and at the same time study the advisability of purchasing power to produce blast-furnace air.

We had used compressed air at one time or another to drive mine sinking hoists, mine pumps, etc., temporarily, but these were all of the slide-valve type. What compressed air would do in a rotary valve engine we did not know, and as far as we could find out, nobody else did either.

We decided to try it, however, and selected a compound-corliss, blast-blowing engine with 13¼x24x42-in. steam cylinders and 57x57x42-in. air cylinders. It was designed to operate non-condensing on 150-lb. saturated steam and to produce 50-oz. air pressure. Maximum engine speed was 80 r.p.m. We thought it was probably impossible to expand the 120-lb. air in both the high- and low-pressure cylinders because ice would form in the low-pressure cylinder. To avoid difficulty, we piped 120-lb. air only to the high-pressure cylinder and 14-lb. air from the copper converter turbo-blower to the low-pressure cylinder. To prevent too great expansion of air in the high-pressure cylinder, its exhaust was piped into the 50-oz. air line going to the blast furnace. This arrangement increased the capacity of the blowing engine by the amount of this exhaust air. Air from the low-pressure cylinder was exhausted to atmosphere, for complete expansion was desired.

Engine speed was controlled by a fly-ball governor which adjusted cutoff on the high-pressure cylinder. Cutoff on the low-pressure cylinder was set by hand.

With this arrangement, the engine operated very satisfactorily and supplied 15,000 to 20,000 cu.ft. of air per min. at a pressure of 20 to 35 oz., depending upon blast furnace requirements. The exhaust from the low-pressure cylinder did not freeze, regardless of per cent of cutoff. Exhaust from the high-pressure cylinder had to be watched, for when the load was light, cutoff would occur too early and allow too great air expansion in the cylinder. Freezing would then result. We prevented this by one of the three following methods:

1. By shortening cutoff on the low-pressure cylinder, thus shifting more load to the high-pressure cylinder. This caused the governor to lengthen cutoff and reduce expansion.

2. By reducing the pressure of the air entering the high-pressure cylinder. This was done by reducing the pressure of the air produced by the air compressor, causing the governor to lengthen the cutoff and reduce expansion.

3. By cutting down the amount of water used in the intercooler of the high-pressure air compressor so that air entering the steam cylinder was hotter.

Mechanically, operation of a compound corliss with compressed air instead of steam was very satisfactory. No trouble was experienced in properly lubricating the steam cylinders. Mechanical force-feed lubricators were used, with the oil piped to the steam lines about 6 in. above the point where they were bolted to the cylinders. Oil to the low-pressure steam cylinder was piped into a ½-in., 120-lb. pressure air line before entering the steam line to the cylinder, because we thought a little high-pressure air might help distribute the oil. This may not have been necessary. Air compressor oil was used to lubricate the steam cylinders, although from our experience we feel that high-pressure steam cylinder oil would have been satisfactory. The engine ran six months before the electric blower was ready for operation, but when we shut the engine down, the cylinders and valves looked just as good as before.

From a power-input point of view, such operation could not be justified unless the peculiar conditions which existed in our case could be duplicated. We shut down a boiler plant and absorbed the no-load losses of a compressor that at the time was being run far below its economical capacity. The same arrangement, however, might prove very useful in a plant in emergency. Almost no piping changes are required.

We also piped up a spare blowing engine with 15x33x42-in. steam cylinders and 70x70x42-in. air cylinders to operate on air. It was satisfactory on trial runs, but we found it unnecessary to run this engine continuously, for the other engine furnished enough air to meet all air demands during the changeover.

10 WAYS TO WEIGH COAL TO BOILER FIRING EQUIPMENT

1. **As delivered to bunker**
2. **By wheelbarrow load**
3. **Coal car and platform scale**
4. **Recording tachometer on stoker or feeder**
5. **Graphic tachometer on stoker or feeder**
6. **Meter on coal spout to stoker on pulverizer**
7. **Apron feeder and automatic scale**
8. **Hand-operated weigh larry**
9. **Power-operated weigh larry**
10. **Semi-automatic weigh larry**

BEFORE a boiler plant can be operated at best efficiency, records of its performance must be available. Weight of fuel delivered to each boiler is a vital element of these records. If the fuel is coal, some type of weighing device is essential; the most suitable type will depend upon such factors as how coal is delivered and method of firing.

Where boilers are hand-fired and coal is brought into the boiler room by wheelbarrow, the barrow loads may be weighed and a record kept. If a platform scale is available, each load may be weighed individually. Even though a platform scale of proper capacity is desirable, it is not absolutely essential. In one plant, the engineer could not obtain funds with which to buy such a scale. He bought a 10-cent spring scale. With this, a wheelbarrow load of coal is weighed, bucket by bucket, and the barrow load then used as the unit of measurement.

To eliminate errors as far as possible, the barrow is fully loaded. It is to the fireman's interest to load the barrow this way, for underloading shows an apparent increased coal consumption. A record is kept of the barrow-loads by the firemen. As a check, the loads are automatically counted by a recorder on the switchboard. This recorder is connected to an electric switch so located that the barrow must pass over it when going from bunker to boiler-room.

To take into account changes in coal characteristics, a barrow is checked periodically with scale and bucket. It has been possible with this rather crude method to obtain a fairly close check between weight of coal purchased and that weighed to boilers.

When firing is done by hand and coal must be wheeled into the boiler room, a steel coal car and a platform scale, Fig. 1, make a good combination. Each load can be weighed as it is brought into the boiler room and firing done directly from the car. The weight of coal can be recorded automatically, insuring a high degree of accuracy and eliminating the possibility of lost weights. By delivering the coal directly from car to furnace, the firing aisle is kept free of fuel and a tidy boiler room is maintained.

When coal is taken from an overhead bunker for hand firing, it may be weighed by the same means, on a scale or a coal meter may be installed in the spout leading from bunker to fire-room floor. The latter will be given further attention subsequently. As mentioned in the February article, by calibrating the boiler bunker and weighing the coal into it, the amount burned in any given period can be determined.

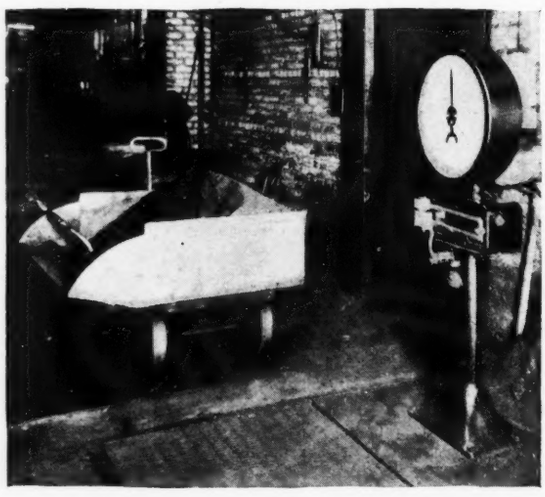
Over long periods, this method is fairly accurate, but for short periods (such as an 8-hr. shift) checking the coal level does not give accurate results. Weighing coal as received is highly desirable for two reasons. It makes certain that the weight purchased is delivered, also provides a way to check the amount fired. If boilers are to be maintained at their best efficiency, however, then the fuel burned under each must be weighed in such a way that performance for each shift is accurately known.

When boilers are fired by underfeed stokers, volume or weight of coal delivered by each plunger may be determined and a counter or a coal meter, Fig. 2, used to record the stoker-shaft revolutions or number of plunger strokes. By the use of a predetermined constant, based on coal characteristics, the weight of coal used in any given period can be calculated.

A method has been developed that uses a specially designed tachometer to give a continuous record of coal fired by underfeed stokers or pulverizers. The tachometer, driven from stoker or pulverized-coal feeder shaft, is connected to the boiler meter to record rate of coal feed on the chart with steam flow, air flow and flue-gas temperature. By having fuel-feed rate and steam flow on one chart, operators can check one with the other and, if necessary, make adjustments to maintain a correct fuel feed.

Where coal is delivered to stokers or pulverizers from

Fig. 1—Platform scale weighs coal in car as it goes to boiler room

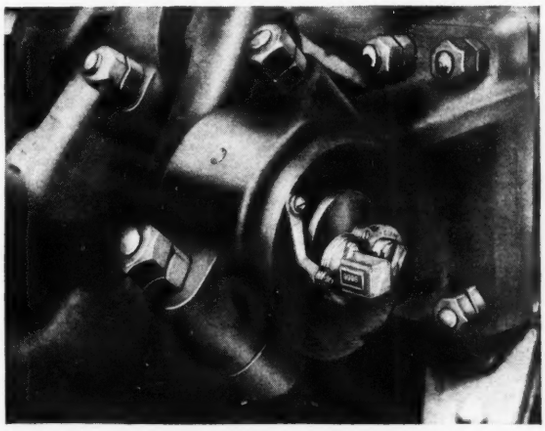


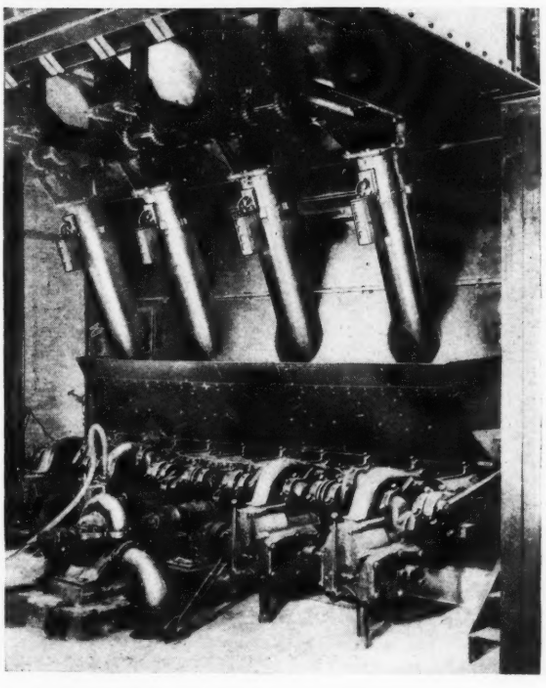
an overhead bunker in the boiler room, any one of several methods can be used to weigh it. First, a coal meter may be installed in each coal spout, Fig. 3. Each meter is operated by a vane projecting into the center of the spout. Coal movement down the spout causes the vane to turn a definite amount for each foot of coal travel in the spout. This motion is transferred through a flexible shaft to the counter.

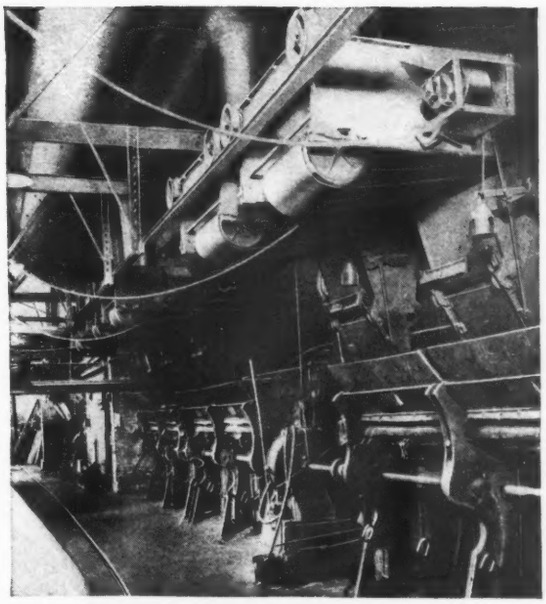
Apron feed scales may be installed in each pipe from the overhead bunker, Fig. 4, and coal weighed to each boiler automatically. This equipment comprises a weigh beam, a receiving chute, a slow-speed power-driven apron feeder, a weighing hopper, a mechanical register and a device for controlling the charge and discharge of the weigh hopper. Where one or more scales is provided for each boiler, each scale is mounted for rolling aside to permit removal of boiler tubes, but otherwise the scale is stationary.

A weigh larry is one of the most generally used methods of weighing coal to boilers. Many forms are available, they may be manually or power operated depending on their capacity, and may weigh manually or automatically and record. They may be suspended or run on tracks in the firing-aisle floor or above the stoker hoppers. Usually they are loaded from an overhead bunker, but Fig. 5 shows one loaded by a portable conveyor and running on a track above the stoker hoppers. The larry is electrically operated and the scale is automatic. After being loaded, the larry may be run to any boiler and coal weighed to its stoker.

Fig. 2 (Below)—Coal meter on underfeed stoker records crank-shaft revolutions. Fig. 3 (Bottom)—Coal meters in spouts from bunker to stoker







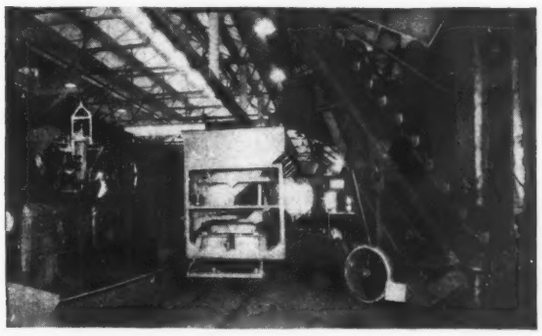


Fig. 4 (Top)—Apron-feeder automatic scales weigh coal from bunker to stokers. Fig. 5 (Above)—Electric coal car equipped with automatic scale weighs coal to stokers

The larry, Fig. 6, is hung from an overhead support, with the scale head, which is of the automatic indicating type, mounted on the larry frame near the boiler-room floor. The scale dial indicates 1,000-lb. capacity. Connected with the indicating mechanism is a graphic recorder which provides a record of all loads discharged to stokers as well as their time of discharge. The recorder is padlocked so that only authorized persons may have access to the chart, which provides a true record of coal weighed.

The installation, Fig. 7, is a 20-ton double-hopper larry that takes coal from an overhead bunker and weighs it to the stoker hoppers of two rows of boilers. The operator, riding on a platform suspended from the larry, manipulates the larry, weighs coal and delivers it to stokers.

Still another arrangement is shown in Fig. 8. Here a small power-driven weigh larry operated from the firing aisle takes coal from an outside bunker and weighs it to stoker hoppers. Weigh larries of this type

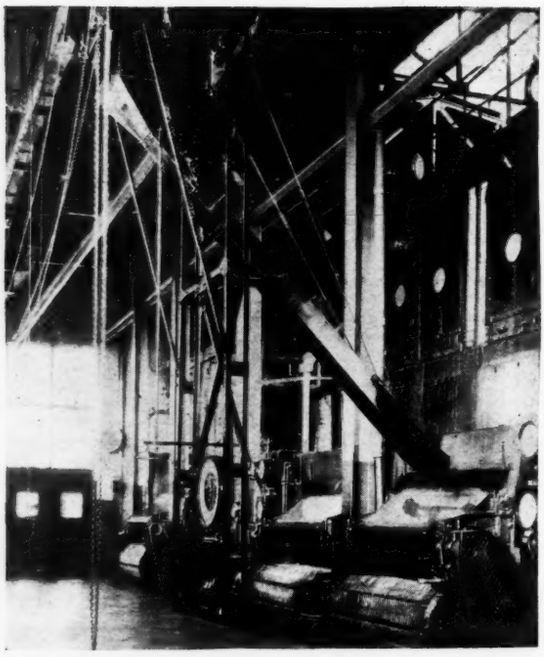


Fig. 6—Weigh larry equipped with dial scale and automatic weight recorder

are also arranged to run on tracks in the firing-aisle floor and carry the operator.

Weigh larries that are semi-automatic are available. With these, the boiler attendant presses a button in front of any boiler and the larry, which has been automatically loaded, travels to the selected boiler. After dumping its load into a stoker hopper, the attendant releases the larry and it returns for another load.

Modern trends are away from a long overhead boiler-house bunker to an elevated bunker either in the middle of the boiler house or at one end. This construction makes a weigh larry necessary to convey coal to the boilers. By using an external bunker, the boiler house is simply a covering over the boilers and does not require the heavy structure necessary for an internal overhead bunker. With a long overhead bunker having spouts to each boiler, if one boiler is out of service, the coal in front of it is not available for the others. If a weigh larry is used, coal in any part of the bunker can be used and a smaller bunker will suffice.

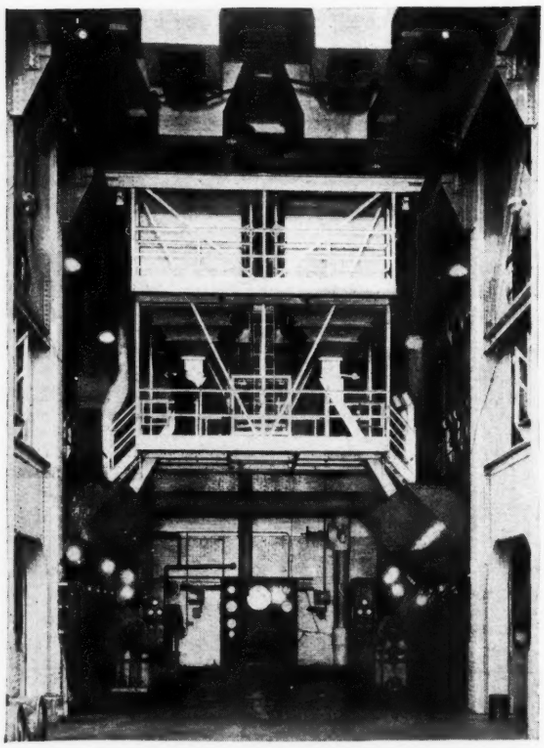
A traveling weigh larry gives a clear firing aisle, there being no coal chutes to interfere with the cleaning of boilers or removal of tubes. If the external bunker and larry are used, it allows for good lighting and ventilation. This is not true when the boiler house contains an overhead bunker.

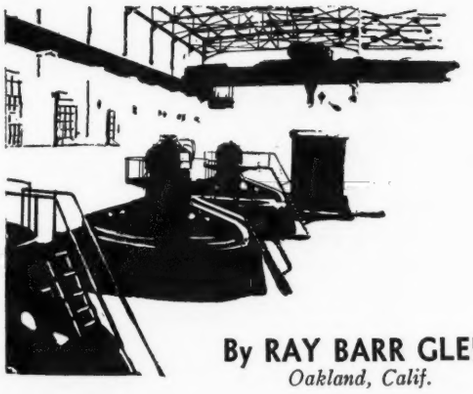
Prevention of segregation of lumps and fines in the stokers is one of the more important functions of the larry. When the operator fills the stoker hopper, he opens the discharge gate and moves the larry back and forth slowly, so that segregation is eliminated and better stoker and furnace operation obtained.

There is always present the possibility of fires in the overhead bunkers, due to spontaneous combustion. The fire usually occurs in a bunker section where coal is dormant, due to a boiler being out of service. With fixed spouts, there is only one thing that the operator can do; spill the coal out on the floor, and put out the fire with water. With a weigh larry, if a hot spot develops in the bunker, the coal can be immediately taken out and used in the regular way in the boiler furnace.

Assistance in the preparation of this article is acknowledged to C. O. Bartlett & Snow Co.; Streeter-Amet Co.; Richardson Scale Co.; Toledo Scale Co.; C. J. Mfg. Co.; Gifford Wood Co.; Stephens-Adamson Mfg. Co.; Bailey Meter Co.; Merrick Scale Mfg. Co.; Atlas Car & Mfg. Co.; Howe Scale Co.; Link Belt Co.; Chain Belt Co.; Jeffrey Mfg. Co.; Heyl & Patterson, Inc.; Fairbanks, Morse & Co.; Webster Mfg. Co.; Industrial Brownhoist Corp.; Robins Conveying Belt Co.

Fig. 7 (Below)—A 20-ton weigh larry delivers coal to two rows of boilers. Fig. 8 (Bottom)—Power-operated weigh larry in small boiler plant





SOME CAUSES OF PENSTOCK FAILURES

By RAY BARR GLEN
Oakland, Calif.

BECAUSE of the great damage that can result when water under pressure gets out of control, hydraulic power equipment must be properly maintained and intelligently operated. Penstock failures have resulted from many causes, most of which are avoidable. These cases are typical:

While workmen were tightening bolts on a penstock valve, it burst and the water caused extensive damage before it could be stopped. A somewhat similar failure occurred following the removal of concrete near a cast-iron nozzle body. Apparently, part of the stress was being taken by the concrete, for a few hours after its removal the nozzle body burst and considerable damage resulted.

In another station, a turbine had been taken out of service for inspection and its penstock drained. After removal of the turbine manhole cover, water was inadvertently admitted to the penstock. Before the water could be shut off, the roof above the open manhole was blown away, and other damage resulted.

It is well known that penstocks have collapsed because sufficient air was not admitted to them when they were drained. One must view a flattened penstock to appreciate the great damage that can result from this cause.

Excessive pressures in penstocks are commonly due to faulty operation of governors and relief valves. Satisfactory operation of this equipment cannot be expected unless it is well cared for. Self-evident is the fact that a moving column of water, which is almost as incompressible as steel, cannot be quickly stopped without a high pressure rise.

In one case, the correct procedure was to fill the nozzle body by opening the bypass valve, then opening the hydraulically operated penstock valve after the pressures became equalized. Through an error, the penstock valve was opened while the nozzle body was empty, and the inrush of water caused a severe surge. Not only did the penstock connected to this valve burst, but one adjacent, and connected to it at a point nearly a half mile away, also failed. Before the flow of water could be stopped, the switch yard was deeply covered with débris, and a large quantity of soil had been washed into the station. The rise in pressure was undoubtedly great enough to wreck a penstock of any type, but defective welds were exposed at the point of failure. At that time, reliable weld tests had not been developed.

Failures have been caused by changes in penstock length due to variations in temperature. At one station the penstock sections were of welded construction, the sections being flanged and bolted together. On a very cold day, the bolts at one joint pulled apart about 2 in. and considerable débris was washed into the station before the water could be shut off.

Considering cases of damage due to the uncontrolled flow of water under pressure, it is obvious that the damage has been least serious when the discharge was of brief duration. With reference to high-head stations, it follows that valves should be provided to stop flow into a penstock quickly. At some stations provisions have been made for automatic closing of penstock supply valves when the velocity of the water exceeds a definite value, such as would result in the event of a penstock failure. Some plants have been intentionally so located with reference to the penstocks that failure thereof will not damage the station unless the break is in close proximity. Penstock failures are not likely to occur in modern, well-operated stations; nevertheless operating instructions applying to this serious emergency should be firmly fixed in mind.

INSTALLED WATER POWER TOTALS 39,257,000 KW.

THIS table gives developed water powers in the world in those countries that have in excess of 100,000 kw. installed. These data have been compiled by the American Committee, World Power Conference, of which O. C. Merrill is chairman, at 1419 Chrysler Bldg., New York, N. Y., and are substantially correct. Figures for the United States, Canada, Italy, France, Japan and Czechoslovakia are from official sources. Data for Norway and Sweden are from information presented at the sectional meeting of the World Power Conference last year in Scandinavia. The German figures were taken from a detailed report prepared by the German Water-Power Association. Russian figures were supplied by the office of Col. Hugh L. Cooper, New York, N. Y.

Countries	Installed Kilowatts	Per Cent of Total
United States	11,800,000	30.06
Canada	5,256,000	13.39
Italy	4,348,000	11.08
Japan	3,151,000	8.03
France	2,781,000	7.08
Germany	2,300,000	5.86
Switzerland	1,900,000	4.84
Norway	1,850,000	4.71
Sweden	1,400,000	3.57
Spain	875,000	2.23
U.S.S.R.	758,000	1.93
Austria	725,000	1.85
Brazil	525,000	1.34
Finland	300,000	0.76
India	300,000	0.76
Mexico	235,000	0.60
Great Britain	228,000	0.58
New Zealand	225,000	0.57
Jugoslavia	190,000	0.48
Czechoslovakia	110,000	0.28
Total	39,257,000	100.00

PLUGGING THE LEAKS

CUTS FUEL COST 40%

By E. S. BROWN
New York City

In a small heating plant, eliminating obvious losses and changing the grade of fuel used showed decided savings over former slip-shod methods

METERS are essential to the operation of a steam plant at its highest efficiency, but their absence is no excuse for not keeping equipment clean and well maintained. Even though a pressure gage and water column are the only devices available with which to operate boilers, if they are well maintained and a little judgment used in firing, a large part of the losses frequently occurring in plants can be eliminated. Here is an example of improvements in operation that can be made even under unfavorable conditions.

In May, 1931, I took charge of a small hospital boiler plant in which there is installed one horizontal return-tubular boiler and one vertical fire-tube boiler, two duplex boiler-feed pumps, a vacuum pump on the heating system and a service-water heater. Exhaust from feedwater and vacuum pumps is used for heating service water for the hospital and a laundry. A 90-lb. live-steam line runs to the hospital for sterilizing and other purposes and another high-pressure line runs to the laundry. Heating steam was taken from the high-pressure header through a reducing valve that reduced pressure from 90 to 5 lb.

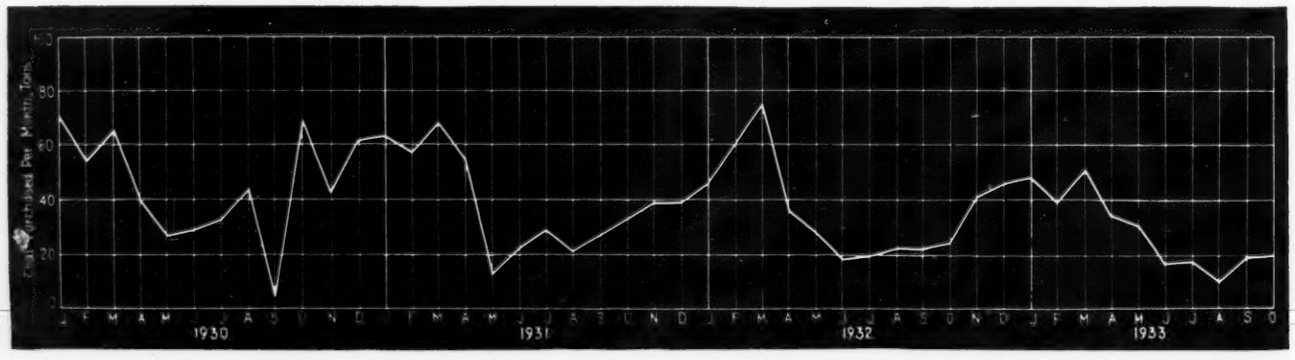
When I took over the plant, consumption of steam seemed to be unusually high, considering the equipment being supplied. An inspection of the boilers showed them to be in fairly good condition on the inside. Their settings were also in very good condition, but on the fire side of the tubes there was a hard scale about $\frac{1}{8}$ in. thick. At first opportunity, the boilers were cleaned. It required efforts of two husky men to push the scraper through the tubes to remove the scale, a turbine cleaner not being available. To clean one boiler having forty-four 4-in. tubes required two nights' work.

Draft for boilers was so poor that it was difficult to maintain full steam pressure during times of normal demand. A search for the cause revealed a 3-in. space around the breeching where it went into the stack. Apparently, it had never been sealed into the stack connection. When this was corrected, draft was more than enough for all load demands.

On a high-pressure service line was a $1\frac{1}{2}$-in. trap discharging to a receiving tank from which the boiler feedwater was taken. This trap was stuck open, and steam was blowing through it to the receiving tank and to atmosphere. This trap was replaced with a $\frac{3}{4}$-in. trap which happened to be available. It proved to have ample capacity and gave satisfactory service. All other traps were leaking; these were put into good condition or replaced.

Service water was intended to be heated normally by exhaust steam from the pumps. This exhaust line connected to the heater and had a back-pressure valve that was supposed to open when pressure exceeded 5 lb. The high-pressure steam line also connected with the heater through a reducing valve followed by a thermostatically controlled valve. The reducing valve was supposed to maintain 5 lb. on its low-pressure side, and the thermostatic valve was supposed to stay closed when the temperature in the heater was above 140 deg. F. Each of these valves had a by-pass which I found open. The back-pressure valve on the exhaust line to the heater was stuck open so that it could not close. As a result, high-pressure steam was blowing continuously through the valve by-passes, the heater and out the back-pressure valve to atmosphere. Needless to say, correction of these conditions cut steam demand substantially.

In the laundry, the hot-water valve in the washer line was leaking badly; water was going into the washer and overflowing to the sewer continually. This leak and many others were corrected.



Apparently the water heater was in bad condition when first I came on the job, for the following winter steam demand, as indicated by coal burned, increased very rapidly. An investigation revealed that the steam coils were ruptured in several places. When new coils were installed in the heater, fuel consumption dropped back to normal.

Stopping the leaks mentioned and making other improvements reduced coal consumption from 556 tons (for the 12 mo. just previous to my coming to the plant) to 398 tons for a corresponding period in 1932-33. This is a reduction of 28.4 per cent, accomplished by doing things that obviously should be done.

The curve shows tons of coal purchased month by month from January, 1930, to October, 1933, when I left the plant. In February and March, 1932, coal consumption was high because of tube failures in the water heater. When this was corrected, coal consumption dropped back to normal again. This curve does not give an absolutely correct picture of the coal burned each month, as there is a small amount of storage. Over a year's period, however, the curve does give a very close indication of coal used.

Beginning with July, 1933, the fuel burned was changed from No. 1 buckwheat to a mixture of equal parts of bituminous slack and petroleum-coke breeze. This change reduced fuel cost 40 cents per ton and improved combustion efficiency so that total yearly savings in fuel cost from all improvements will be around 40 per cent compared to the year April, 1930 to 1931.

No meters or other equipment were added to the plant to assist in improving its efficiency. All improvements made in boiler and furnace efficiency were those that any conscientious fireman could accomplish by using judgment in firing and taking care of the boilers and settings. Probably another 10 per cent could have been saved by equipping the boilers with devices so that they could be operated at their best efficiency all the time.

GAS ENGINES IN ICE PLANT SAVE OWNERS 44 PER CENT

WITH the development of the southwestern natural gas fields, many ice and refrigerating plants in the district have been converted to gas-engine drives and new plants have almost always installed gas engines. Fairly complete data on one of these new plants is given in the accompanying tables, which were released for publication under the condition that the company name be not given.

These figures show an annual cost of $11,376.42 for the plant, including interest charges at 6 per cent and depreciation at 7½ per cent, for an actual output of 1,658,400 kw.-hr., which if purchased, would cost $20,560.32. This is a decrease of 44.6 per cent in the annual cost for power, and will repay the cost of the installation in slightly over four years.

Several elements of the table require explanation. It will be noted that taxes (under annual fixed charges) are apparently the figure for the entire ice manufacturing plant, instead of for the power plant alone. On the other hand, no figures are given for labor or maintenance. It is probable that the power engineer also handles the compressors, thus would only charge a small part of his time to the power plant itself. Maintenance is negligible so far, since the engines are new.

The plant consists of three 240-hp., 8-cyl., vertical gas engines, each driving a 175-kw. alternator at 450 r.p.m. Natural gas of 1,050 B.t.u. per cu.ft. heat content is the fuel. City water is used for cooling in the spray-pond system, 200 g.p.m. being circulated. Lubricating oil is filtered, and runs 2880 b.hp.-hr. per gal.

INITIAL INVESTMENT

3—175-kw., 450-r.p.m., 480-volt, 3-phase, 60-cycle alternators, direct-connected to 8-cyl. gas engines. Total cost, delivered		$29,910.00
1—Power switchboard, and including complete electrical installation of generators, switchboard and lights in generator room		3,900.00
Installation of engine and accessories, including:		
Foundations	$759.20	
Pipework	898.80	
Unloading	150.00	
Erection Superintendent	160.00	1,968.00
Total Installation Cost, Building, Floor, etc		2,722.00
Total Investment		$38,500.00

ANNUAL OPERATING COSTS

FIXED CHARGES:		
Interest at 6%		
Depreciation at 7½%		
Total, 13½% on the initial investment		$5,197.50
Taxes		1,500.00
Total Annual Fixed Charges		$6,697.50
OPERATING EXPENSES		
Fuel, Natural Gas, 28,192,800 cu. ft. at 15c per 1,000 cu. ft	$4,228.92	
Lubricating Oil, 750 gal. at 20c	150.00	
Water for cooling purposes	300.00	
Total Operating Expenses		$4,678.92
Total Expense, Fixed Charges and Operating Expenses		$11,376.42

ELECTRIC CURRENT PRODUCED DURING 1932

	Kw.-hr.	Cost of Energy Under Existing Rates
January	69,500	$1,222.31
February	57,900	1,094.71
March	53,200	933.01
April	102,100	1,576.71
May	157,900	2,078.91
June	175,000	2,232.81
July	204,000	2,493.81
August	190,100	2,368.71
September	180,300	2,280.51
October	124,600	1,779.21
November	103,800	1,542.01
December	40,000	897.81
Total for 1932	1,658,400 kw.-hr.	$20,560.32

Cost per kw.-hr., based upon a total operating cost of $11,376.42, and total current produced, 1,658,400 kw.-hr ..... 6.8 mills/kw.-hr.

The capacity factor for 1932, based upon the possible output of 4,536,000 kw.-hr., at 100 per cent time and capacity, and with an actual output of 1,658,400 kw.-hr., is 36 per cent.

Beer Makes Cheaper Beer—Last summer the breweries started work on 3.2. In December they switched to 3.2+. Prohibition is dead and complete beer is here, apparently to stay. All of which points to one thing, speaking from the power angle: A lot of brewery modernization.

No brewer can compete permanently with the antique power equipment which creaked and limped to carry him through last summer. After all, there *is* a lot of coal in a barrel of beer, and coal costs money. The 60 per cent fuel saving possible with modern steam and refrigerating equipment, plus a by-product power hookup, cannot be sneezed at.

Understanding this, many breweries are completely rebuilding their power plants right now to beat next summer's rush. Beer profits of last summer are helping to pay the bill. With inefficient operation, those profits were possible because practically all competitors were in the same fix. Not so today.

WHO'S BILLED FOR BLOWDOWN?

NOT THE BOILER!

Says S. H. COLEMAN

WHEN calculating over-all boiler efficiency for daily or monthly records, the heat recovered from boiler blowdown systems is commonly neglected. As continuous-blowdown heat-exchange equipment finds its greatest justification in plants requiring large quantities of makeup water and having a heat balance deficient in exhaust steam for feedwater heating, this gain in boiler efficiency is appreciable and should be included in the over-all total.

In calculating boiler efficiency, the fundamental formula is heat output divided by heat input. Therefore it is reasonable to include in the heat output that heat imparted to the blowdown which is recovered in the heat exchanger. This heat is the total heat in the blowdown water above the temperature of the feedwater.

If the total quantity of blowdown is known and its temperature leaving the heat exchanger is lower than the boiler feedwater temperature, the corrected over-all boiler efficiency based on total usable heat output may be calculated by the formula:

$$\text{Over-all efficiency} = \frac{W_s(h_2 - h_4) + W_b(h_3 - h_4)}{C \times W_c},$$

where W_s = weight of steam generated, lb.; W_b = weight of continuous blowdown, lb.; h_2 = total heat in steam per lb.; h_3 = total heat per pound in blowdown water entering heat exchanger; h_4 = total heat per pound in boiler feedwater entering boiler; W_c = weight of fuel, lb.; C = heat value of fuel.

For example, assume a boiler generating 10,000 lb. of saturated steam an hour at 250 lb. gage pressure with feedwater entering the boiler at 212 deg., and burning 1,000 lb. of 13,000 B.t.u. coal per hour.

The blowdown from this boiler is 1,000 lb. per hour, or 10 per cent of the evaporation. After passing through a heat exchanger, this blowdown water is discharged to the sewer at a temperature below the temperature of the boiler feedwater.

The efficiency of the boiler by the usual method of calculation would be:

$$\frac{10{,}000\,(1201.2 - 180)}{1{,}000 \times 13{,}000} = 78.6 \text{ per cent}$$

If the boiler is credited with the heat in the blowdown above the temperature of the feedwater, the over-all efficiency by the suggested formula becomes:

$$\frac{10{,}000\,(1201.2 - 180) + 1{,}000\,(381.6 - 180)}{1{,}000 \times 13{,}000} = 80.15$$

When interpreting the above calculations, care must be taken to avoid confusing the calculated gain in boiler efficiency with the total efficiency of the continuous blowdown heat exchanger as heat-recovery equipment.

WHAT'S A BOILER?

Asks C. HAROLD BERRY

MR. COLEMAN has raised an interesting point, and it seems to me that proper discussion demands that we go right back to first principles.

In considering the efficiency of any assembly of apparatus, it is important that we define just what apparatus is included and that we state clearly what is to be considered the useful output and the chargeable input. For example, we may have a plant that furnishes both power and heat. The useful output is then the total energy output, the sum of the power and the heat, reduced, of course, to like units. The chargeable input is the heat in the fuel. The efficiency is the ratio of these two, and may be 80 per cent, perhaps even higher. On the other hand, we may wish to know how efficient this plant is in the production of power alone, and for this purpose we shall consider that the power is the only useful output and find an efficiency of perhaps 10 per cent. Both efficiency values are correct, and both are perfectly proper, but we must in each case make it clear just what the figures mean.

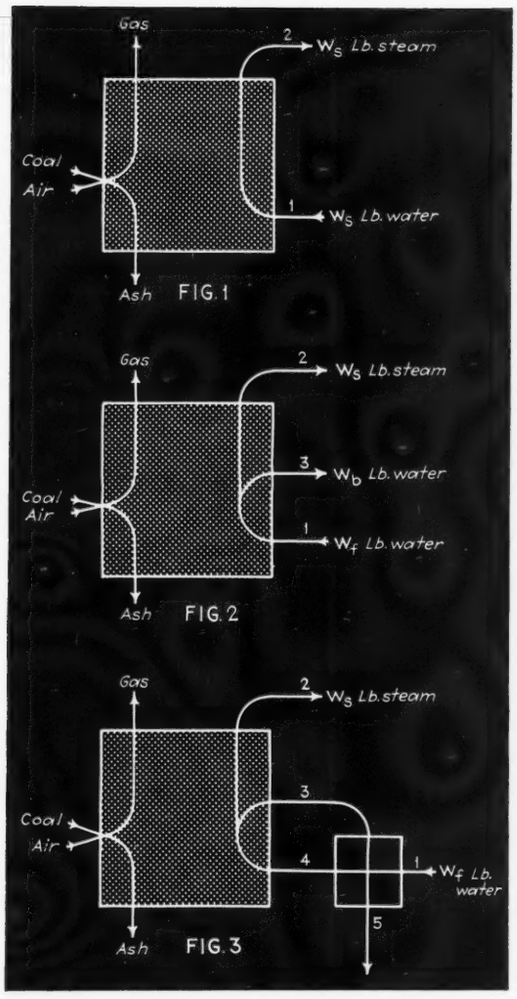
Consider a simple boiler, represented in Fig. 1. It receives coal, cold air, and cold water. It delivers hot ash, hot gas and steam. Its chargeable input is coal, and its useful output is steam. These must be put into comparable terms—that is, in terms of heat. The input is the weight of coal, multiplied by its heating value $= C\ W_c$. The output is the heat necessary to produce the steam from the water that is supplied to the boiler $= W_s\ (h_2 - h_1)$.

The boiler delivers a stream of hot gas which, if it were cooled to the initial air temperature, would yield a quantity of heat that the boiler fails to catch. This is the loss due to the discharge of hot gas. Similarly for the hot ash-pit refuse.

As a second step, let us consider a boiler operated with continuous blowdown, but with no means for recovering the resulting heat loss. Fig. 2 indicates the situation. The boiler now has a new output—hot water. Put into heat terms, this new output is the heat necessary to produce the hot blowdown water from the water fed to the boiler $= W_b(h_3 - h_1)$. But, under the circumstances, this output is useless and cannot be credited to the boiler. It is waste heat, just as is the heat loss resulting from the discharge of hot gas up the chimney.

Now, let us look at the boiler equipped with a blowdown heat exchanger. Fig. 3 indicates the situation. We may study this assembly as a whole, or we may confine our attention to the boiler alone.

For the boiler alone, the outputs in steam and in hot water are less than they were in Fig. 2, if the weights are unchanged, because the feedwater entering the *boiler* is hotter than it was in Fig. 2. The heat output



in steam is $W_s\ (h_2 - h_4)$, and the output in blowdown water is $W_b\ (h_3 - h_4)$. But still, so far as the *boiler* is concerned, the output in blowdown water is a waste, not to be credited to the boiler. We do not operate the boiler for the purpose of producing this hot water; it is merely a troublesome and wasteful necessity arising from the impurity of the water supply.

To be sure, if we were computing the heat transfer coefficient of the boiler, we should include the heat absorbed to heat this blowdown water, because this heat is undeniably transmitted through the boiler heating surface. But, from the efficiency and capacity standpoint, this merely indicates the use of boiler capacity for uselessly heating water. We should certainly not do it if the water were free from impurities.

Accordingly, the only useful output of the *boiler* in this case is $W_s\ (h_2 - h_4)$.

But we might consider the efficiency of the combination of boiler and heat exchanger. Then the transfers of hot water from the boiler to the heat exchanger and from the heat exchanger to the boiler are internal to the apparatus, and do not appear in the over-all analysis. The assembly receives water under conditions at state 1, converts part of it to steam in state 2, and another part of it to hot water in state 5. The output in the steam is $W_s\ (h_2 - h_1)$, and the output in hot water is $W_b\ (h_5 - h_1)$. The latter is wasted, and must be counted a loss against boiler-and-heat-exchanger. Only useful output of the unit is $W_s\ (h_2 - h_1)$.

POWER editors realized that many readers would not agree with Mr. Coleman, so we asked Professor Berry of Harvard University, member of the A.S.M.E. Power Test Codes Committee, for his opinion. If you have one too, send it in, but keep it short, please

Mr. Coleman says that "it is reasonable to include in the heat output the heat imparted to the blowdown water by the fuel which is recovered in the heat exchanger." This is true if we are considering the unit comprising both boiler and heat exchanger. On this basis, I agree with Mr. Coleman. But then he goes on to say, "This heat is the total heat in the blowdown water above the temperature of the feedwater." Referring to Fig. 3, Mr. Coleman says that the heat recovered in the heat exchanger is $W_b\ (h_3 - h_4)$. This I believe to be incorrect. The heat balance for the heat exchanger tells us that

Heat given up by blowdown water $= W_b\ (h_3 - h_5)$
Heat received by feed water $= W_f\ (h_4 - h_1)$

These two quantities must be equal, save for losses by radiation, etc. But neither of these quantities is the heat usefully recovered. The only thing for which we give the the apparatus credit is the conversion of water into steam. The heating of blowdown water is not a useful result. It is a necessary evil. Accordingly, we must break down our exchanger heat balance further.

Since $W_f = W_b + W_s$, the heat balance becomes: $W_b\ (h_3 - h_5) = W_b\ (h_4 - h_1) + W_s\ (h_4 - h_1)$.

It is only the final term that can fairly be credited as heat recovered and usefully applied, and from above: $W_s\ (h_4 - h_1) = W_b\ (h_3 - h_5 - h_4 + h_1)$.

As I understand him, Mr. Coleman proposes to credit the boiler-and-heat-exchanger with an output equal to $W_s\ (h_2 - h_4) + W_b\ (h_3 - h_4)$.

The discussion given above indicates that the useful output of the combined boiler-and-heat-exchanger is $W_s\ (h_2 - h_1)$. Let us see how this agrees with Mr. Coleman's proposal:

The exchanger heat balance equation just developed tells us that two quantities are equal. Let us add one of these to Mr. Coleman's expression and subtract the other. This will leave the final value unaltered:

$$W_s\ (h_2 - h_4) + W_b\ (h_3 - h_4) + W_s\ (h_4 - h_1) - W_b\ (h_3 - h_5 - h_4 + h_1) = W_s\ (h_2 - h_1) + W_b\ (h_5 - h_1)$$

It now becomes clearly evident just what would be the result of using Mr. Coleman's proposed formula. It would give the boiler-and-heat-exchanger unit credit not only for the steam produced, but also for the hot water passing to waste from the heat exchanger. It might be argued that the wasting of this heat is due to defects in the heat exchanger, and is no fault of the boiler, but in reply it can be said that the proposed efficiency includes the heat exchanger, whose defects must be included along with its benefits. If we do not count its losses as losses, we may not count its heat recovery as a gain.

HIGH-PRESSURE TURBINE TAKES LOAD IN 36 SEC.

THAT'S FLEXIBILITY

By V. F. ESTCOURT
Pacific Gas & Electric Co.,
San Francisco, Calif.

Station A, San Francisco, has standby 50,000-kw. high-pressure compound turbines which may suddenly be required to carry full load. One turbine took 45,000-kw. load in 50 sec. without causing abnormal steam or electrical conditions

WHAT happens when standby high-pressure equipment is suddenly required to take full load? Engineers at 1,400-lb. Station A of Pacific Gas & Electric Co. wanted to know. Load tests on one 50,000-kw. compound turbine-generator showed that it took 36 sec. to pick up rated full load from an initial load of 10,000 kw.

This turbine was formerly used on base-load service, due partly to a several-year shortage of water and consequent lack of hydro-electric power on the system. With improved conditions, Station A was changed over for standby service, the two 50,000-kw. units operating at or near their minimum load of 5,000 kw. and the three boilers operating with all gas burners in service at pressures as low as 0.05 lb. Many things might happen to high-pressure equipment in case of rapid load pickup under these conditions. Important questions were:

Will the high-pressure generator become overloaded or pull out of step with the low-pressure generator because the increased steam flow affects the high-pressure turbine first, thus causes it to take most of the load until the pressure in the cross-over piping readjusts itself?

Will the pressure differential across some diaphragms in the high-pressure turbine be excessive?

Will reheat temperature be excessive?

Will boiler water level "swell" or increase excessively due to sudden increase in the rate of steam liberation?

Will time required to increase fuel and air flow to the boiler cause too great a drop in steam pressure?

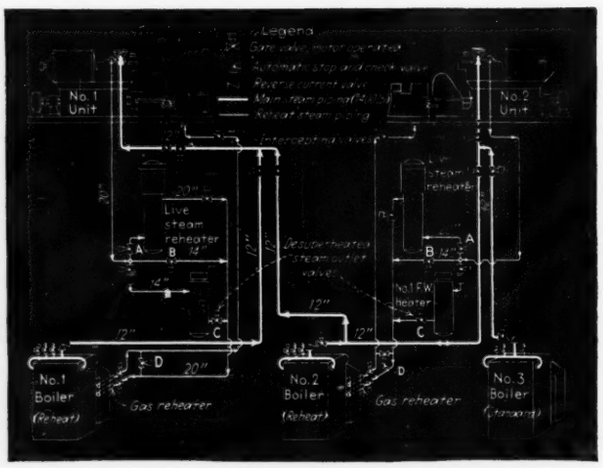
In the general arrangement of boilers and turbines, Fig. 1, it is shown that the reheat piping is arranged so that Boilers 1 and 3 can be used to supply steam to Unit 1 and Boilers 2 and 3 to Unit 2. However, Boiler 1 must not generate any more steam than that required by Unit 1. The same restriction applies to Boiler 2 and Unit 2, for any steam generated by a reheat boiler over that required by its turbine-generator results in starving the convection reheater of one of the reheat boilers, causing excessive reheat temperatures. This is mentioned so that it will be clear why only one reheat boiler and one standard boiler were used to carry the load in this series of load pickup tests.

Initial load pickup tests were made with instantaneous load increases of 10,000 to 15,000 kw., the final test being pickup from 10,000 kw. to full capacity. None of the possible limitations above were sufficiently severe to be objectionable. Under full-load pickup, there was momentary overloading of the high-pressure generator, and differential pressure between the third admission and ninth stage exceeded the maximum allowable working differential by about 2½ per cent. Both conditions were so momentary that they were not noticed until the test motion pictures were viewed.

There was no evidence of instability of the high-pressure generator in relation to the low-pressure unit. Reheat temperatures increased from 725 to 775 deg. F. for a few minutes, then returned to about 750 deg., which was entirely satisfactory. The increase in drum water level was only slightly more than that characistic of the setting of the 3-element water-level control, which is adjusted to give approximately 3½ in. rise in water level from minimum to maximum boiler load.

The rate of fuel and air flow was increased from minimum to maximum in about 24 sec. There were no delays chargeable to lighting up burners because it

Fig. 1—Diagram of main and reheat steam piping at Station "A"



is possible to operate at minimum load with all 26 gas burners in service, gas pressure at this load being about 0.06 lb. and increasing to 7.5 lb. at maximum load. This flexibility is not now possible with oil firing, but we confidently believe that there are no inherent obstacles.

At the time of the test, both turbine-generators, each of which has a maximum capacity of 61,000 kw., were in operation and receiving steam from one standard and two reheat boilers. Local pick-up was, however, handled by one reheat and one standard boiler as already explained. Load on the other reheat boiler and turbine was held constant, although the benefit of the steam storage capacity of all three boilers was obtained. This shows up clearly in the illustrations of steam conditions in the plant. Maximum steam pressure drop was approximately 8½ per cent during the test, but as soon as the steam pressure started to recover, no effort was made to hurry recovery to normal.

Tests were made by restraining the turbine governor by blocking it at a steady load of 10,000 kw. The governor synchronizing spring was then run out to the full-load position, and at a predetermined signal the ball-and-socket connection in the restraining device was broken, permitting the governor to open the turbine control valves to their wide-open position in 3 or 4 sec. In Fig. 2 it will be noted that the unit was carrying rated load in 36 sec. and a load of 55,000 kw. 14 sec. later, this being its maximum capacity for the existing steam pressure.

In Fig. 3, the actual rate of fuel input is shown as a solid line; the broken line shows the rate of fuel input corresponding to the same loads under normal steady conditions. The shaded area therefore represents the total additional fuel consumed due to "overfueling" the boiler during the load increase. The extra heat supplied in this way makes up for the heat released from storage due to pressure drop. Part of it is absorbed in heating up the boiler refractory material and part is required to meet the lower efficiency of the boiler during the sudden load increase.

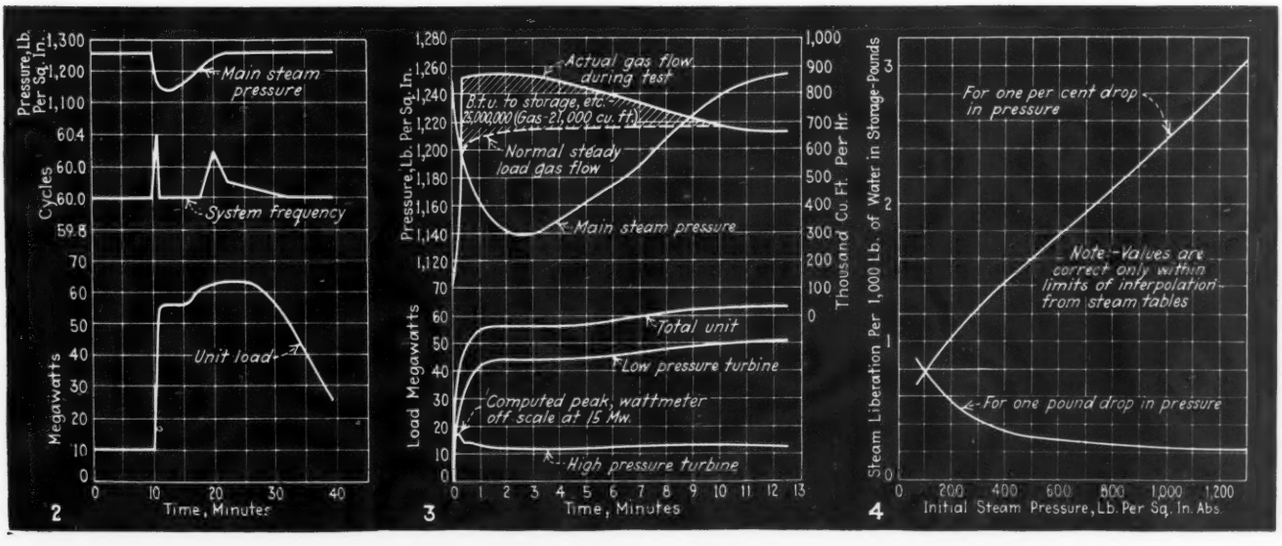
The tests demonstrated the extreme flexibility of the 1,400-lb. plant with centralized control. This control enables one fireman to a boiler to handle these load increments with surprisingly small effort. An annunciator, arranged to operate as soon as the turbine control valves open up any appreciable amount, warns the fireman, who opens one manually-operated drum switch which increases both fuel and air from a minimum to a maximum in less than 30 sec. At a later date, this switch will probably be made automatic.

Relation of the steam storage capacity to operating pressure during large load increases is shown by Fig. 4, in which are plotted the steam liberation per pound of water storage for each pound pressure drop and also for each per cent pressure drop. Since neither steam liberation per pound of pressure drop nor steam volume are as great at the higher pressures, it is clear why the water level problem is almost entirely eliminated during sudden increases in load. In the curve showing steam liberation for each per cent drop in pressure, it can be seen that the storage capacity of a 1,300-lb. plant need be only about half that required for a 400-lb. plant to obtain the same steam liberation from a given percentage drop in steam pressure. Since the capacity of the turbine varies approximately as the steam pressure at the throttle, it can be seen that this curve gives a true picture of the relative amounts of boiler water storage desirable at different operating pressures.

Approximate Turbine Capacities

In Fig. 5 approximate turbine capacities are plotted for a 50,000-kw., 1,250-lb. turbine unit operating at reduced pressures, and in the same figure are plotted the megawatts load that can be carried from the steam liberated from storage for various rates of pressure drop. To plot the total megawatts from storage, the specific conditions under which the test was carried out were assumed, namely, three boilers with a combined storage capacity of 126,000 lb. of water at 575 deg. F. A constant steam rate of 9.4 lb. per kw.-hr. was also assumed, this being the rate for the initial load of 10,000 kw. The assumption that the steam rate remains constant during the pick-up is probably a close

Fig. 2—Load, frequency and steam pressure during load pick-up test. Fig. 3—Fuel input and load distribution between high- and low-pressure turbines during load pick-up test on 50,000-kw. compound turbine-generator unit. Fig. 4—Steam liberation from heat stored in boiler water for different operating pressures


Pressure, Lb. Per Sq. In.
Main steam pressure
Cycles
System frequency
Megawatts
Unit load
Time, Minutes
2
Actual gas flow during test
B.t.u. to storage, etc. 25,000,000 (Gas-21,000 cu. ft.)
Normal steady load gas flow
Main steam pressure
Load Megawatts
Total unit
Low pressure turbine
Computed peak, wattmeter off scale at 15 Mw.
High pressure turbine
Thousand Cu. Ft. Per Hr.
Time, Minutes
3
Steam Liberation Per 1,000 Lb. of Water in Storage-Pounds
For one per cent drop in pressure
Note:-Values are correct only within limits of interpolation from steam tables
For one pound drop in pressure
Initial Steam Pressure, Lb. Per Sq. In. Abs.
4

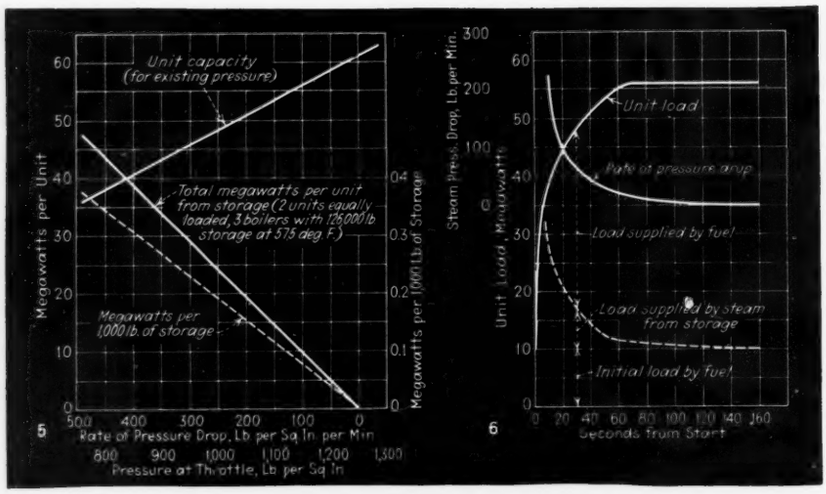

Unit capacity (for existing pressure)
Total megawatts per unit from storage (2 units equally loaded, 3 boilers with 125000 lb storage at 575 deg. F.)
Megawatts per 1,000 lb. of storage
Megawatts per Unit
Megawatts per 1,000 Lb of Storage
Rate of Pressure Drop, Lb per Sq In per Min
Pressure at Throttle, Lb per Sq In
5
Unit load
Rate of pressure drop
Load supplied by fuel
Load supplied by steam from storage
Initial load by fuel
Steam Press. Drop, Lb per Min.
Unit Load, Megawatts
Seconds from Start
6

Fig. 5—Effect of throttle pressure on turbine capacity and turbine load supplied from boiler water storage for various rates of pressure drop. Fig. 6—Actual rate of pressure drop and load supplied by steam from storage during load pick-up test

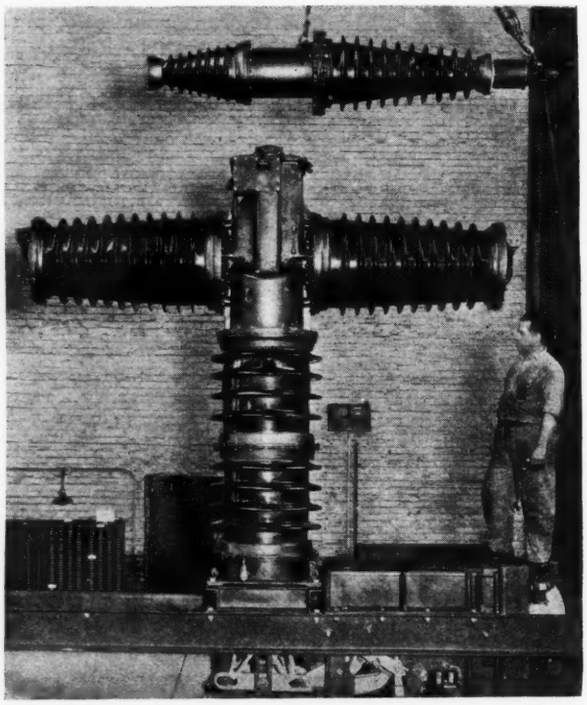
approximation, because this could not be expected to improve very much during the period in which the sudden increase in load occurs. It can be seen from these curves that, for the plant considered, a pressure drop rate of 525 lb. per min. would be sufficient to carry momentarily the nameplate capacity of the unit (50,000 kw.) from the stored heat in the boiler water, without any increase in the rate of fuel input. Actually, the rate of pressure drop is not so severe, chiefly because the steam flow to the unit cannot increase to the maximum instantaneously, and during the time the rate of steam flow is increasing, the rate of fuel flow to the boiler is also being increased, and the rate of pressure drop decreases as the rate of fuel input increases.

In Fig. 6, the actual rate of pressure drop during the load pickup has been plotted, obtained by plotting the values of the tangents to the pressure curve of Fig. 3. Actual megawatts obtained from storage are also plotted here, these values being obtained with aid of Fig. 4. It can be seen that for the first 10 sec. of the test, enough steam was being liberated from storage to carry a load of 32 megawatts, although load did not actually reach this value until after about 5 sec. Fig. 3 also show that the maximum rate of fueling during load pickup was approximately 30 per cent greater than that required for steady load conditions. It is therefore essential that standby plants, in addition to being provided with a certain minimum amount of boiler-water storage capacity, should also contain installed boiler capacity sufficient to permit overfueling 30 or 35 per cent in excess of normal requirements for maximum turbine capacity.

NEW OIL CIRCUIT BREAKER CONTAINED WITHIN INSULATORS

• A HIGH-VOLTAGE, large-capacity oil circuit breaker, containing many features, has been developed by the General Electric Company. Radically different in design, each single-pole unit of the new breaker is shaped like a cross, in contrast to the tanklike construction of conventional equipment. Higher breaking speeds with short arcing times and the use of little oil are among the advantages of the new equipment. Only 96 gal. of oil per pole are required by a breaker with an interrupting rating of 1,500,000 kva. at 138 kv., as compared with approximately 1,700 gal. per pole for a conventional breaker of equivalent interrupting rating.

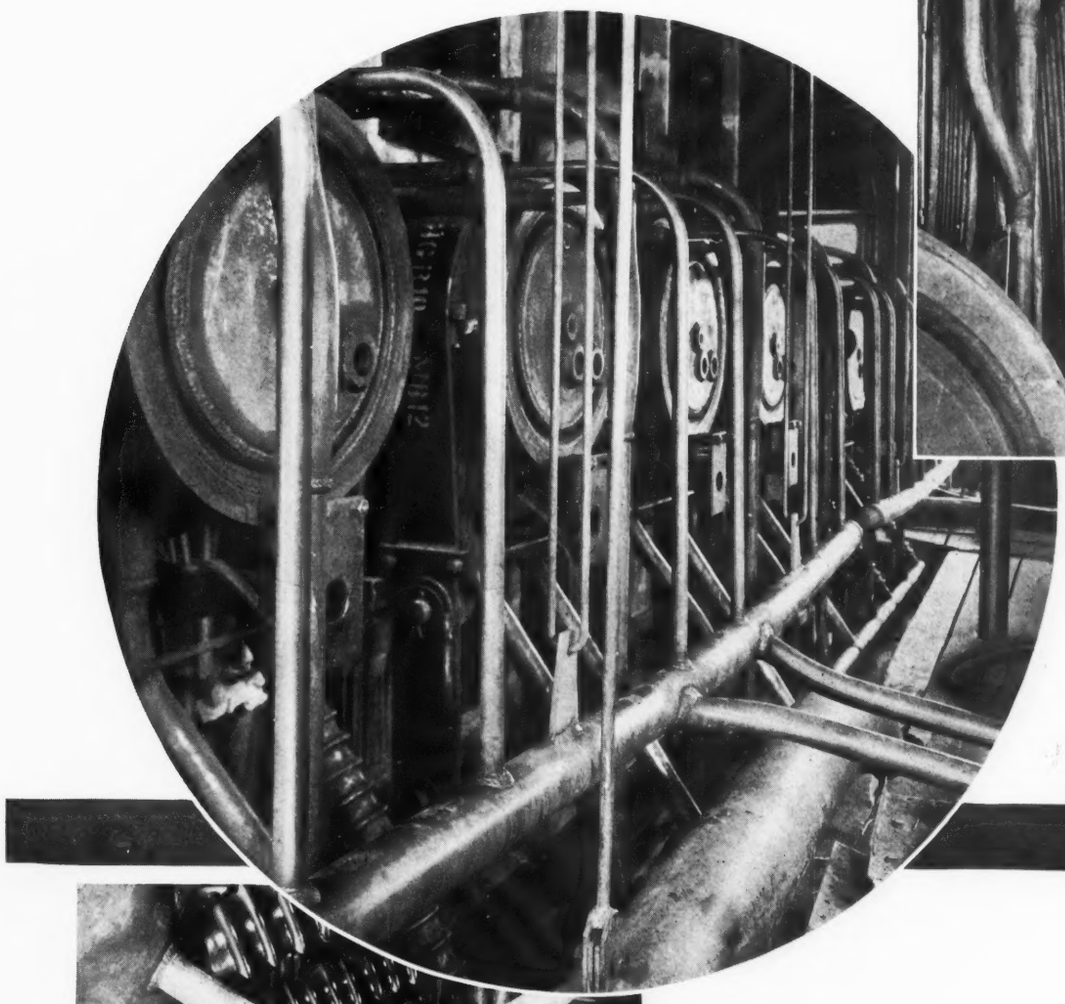
Horizontal containers, not much larger than conventional bushings, enclose the interrupting mechanisms. These containers are mounted on vertical central supports which, in addition to serving in an insulating capacity, also house current transformers when such equipment is required. The operating mechanism is located in the base of each single-pole unit, and an insulated operating rod passes up through the central support to the container. The interrupting elements consist of several sets of contacts in a line, and the inside of each container is so arranged that oil, driven by a piston, is positively directed across the arc path of each of the several arc breaks per pole during circuit interruption. The photograph shows a single-pole 138-kv., 1,500,000-kva. circuit breaker of the new type and one of the two bushings for a tank-type breaker of the same capacity, but conventional design.

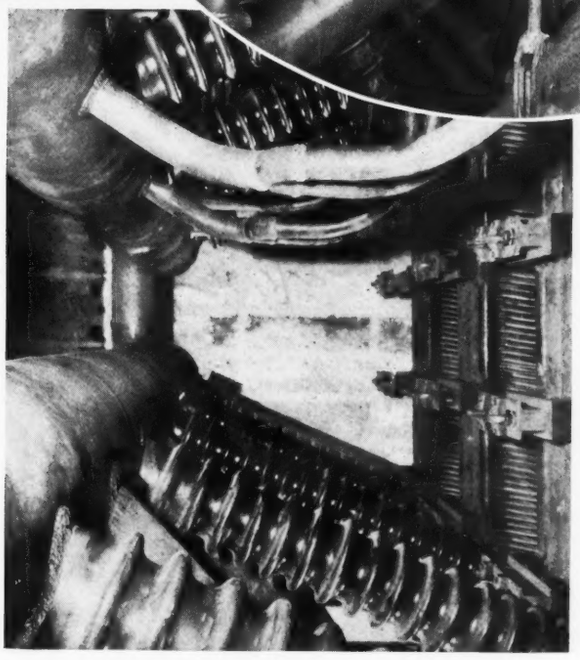


How a single-pole, 138-kv., 1,500,000-kva. circuit breaker of the new type compares with one of the two bushings for a conventional breaker

WELDED HIGHWAYS FOR MERCURY

The all-welded Schenectady mercury-steam station





Liquid mercury, mercury vapor, steam at 400 lb. and 750 deg., water at 600 lb., oil, gas, pulverized coal and air are all carried in A.S.M.E. Code-welded piping, and structure, boilers and equipment are also all-welded, except for a few small purchased standard units. At top is mercury feed and equalizer piping for one of seven mercury boiler drums. In the circular photograph are twelve double-walled mercury liquid heaters, with their overflow connections, which required over 8,000 shop welds. At left are connections from the mercury boiler drums to headers. Equipment fabricated in the General Electric shop was erected and connected by Pittsburgh Piping & Equipment Co., employing qualified G.E. welders. The mercury boiler consists of seven horizontal, parallel drums of 30-in. inside diameter, 4-in. thick, with 440 porcupine tubes hanging from each one and welded inside. Even though welders had to work under forced ventilation inside the 30-in. drum, hydrostatic tests showed only two leaks in the 3,080 tube joints

STEAM ENGINE BEARING LUBRICATION ..

● The bearings requiring lubrication on steam engines consist in general of the main, pedestal, and crank-pin bearings, crossheads and guides, eccentrics, valve gear and governor mechanism.

Enclosed Engines

Engines with enclosed crankcases are designed to lubricate most of the bearings by splash or circulating system. When splash lubricated, the oil is splashed to the various parts by the dipping of the crank or crank disc in the oil. In circulating systems pumps pick up the oil from the sump. It is then conducted usually by gravity through suitable pipe or ducts to the parts to be lubricated.

Copious quantities of oil are supplied to the bearings by such methods and the oil tends to cool the bearings as well as lubricate them.

It is virtually impossible to keep all water out of such lubricating systems and in certain designs the oil is floated on top of water. Because of this presence of water in enclosed engines, it is important that the oil separate quickly from water and settle in the sump and not form undesirable emulsions. If automatic devices are not employed for draining the water from the sump, frequent and regular draining of this water is important, otherwise excessive splashing of the oil and water will occur, increasing the danger of emulsions. Mixtures of oil and water in the form of emulsions flow slowly tending to clog screens and piping, which endangers the lubrication of the engine.

Dust and dirt of various kinds find their way into the lubricating systems. These materials aid in forming emulsions when water is present. Filters for removing such materials from the oil assist in preventing the formation of emulsions.

In enclosed engines some of the oil is thrown against the hot cylinder head which tends to oxidize the oil and cause some oil vaporization resulting in "smoking" or "fogging." "Smoking" or "fogging", can be reduced by using heavier bodied oils because they have greater resistance to vaporization. However, there is a limit to the viscosity which can be used, as heavier oils tend to increase bearing operating temperatures. Usually a compromise can be made resulting in satisfactory bearing temperatures without excessive vaporization.

Certain designs incorporate a bulk head between the cylinder head and crankcase preventing the oil from coming in contact with the hot cylinder head. This reduces vaporization and deterioration of the oil by oxidation. A lighter bodied oil may be used without excessive "fogging."

Bulk heads also aid in preventing condensate caused by steam leaking past the packing from entering the lubricating systems. Condensate from this source will contain some cylinder oil and when compounded oils are used the leakage of the condensate into the oil will increase the danger of emulsions. Packing and rods should be kept in good condition to avoid difficulty from this source.

In some small enclosed crankcase steam engines of the single acting type, the crankcase oil comes into contact with the lower side of the piston and cylinder walls. The resulting oil temperature is much higher than that in double acting engines and consequently a very heavy oil is required to provide proper lubrication. High grade oils are necessary to resist rapid deterioration due to contact with the highly heated surfaces.

For all enclosed crankcase engines oils of highest quality should be used. Only by the use of high quality oils can minimum "fogging", rapid separation from water and maximum resistance to oxidation and sludging be obtained.

Open Type Engines

The bearings of open type engines are generally lubricated by a circulating system or by sight-feed cups. The oil circulation usually is accomplished by pumping the oil to a tank above the engine from which it flows by gravity through pipes to the bearings. From the bearings it is returned to the pump. Sometimes a filter is incorporated in the circuit. The type of oil required for this system is similar to that described for double acting enclosed engines.

Where sight-feed cups are used it is advisable for economy to reduce end leakage of the bearings to a minimum because the oil often is not re-used. A heavier bodied oil is required than that normally used for circulating systems. Sight-feed cups feed oil to the bearings a drop at a time and to maintain a film of oil, the oil must be viscous enough to prevent its ready removal from the bearing surfaces. But oils which are too heavy must be avoided as they increase bearing operating temperatures. If the oil is not re-used, resistance to oxidation and sludging, and separation from water are not imporant factors. Consequently the oil generally need not be of as high quality as that required for systems where the oil is used over and over.

Some pedestal bearings are ring-oiled. This allows the oil to be used over and over indefinitely and the same type of oil should be used in these bearings as is recommended for circulating systems.

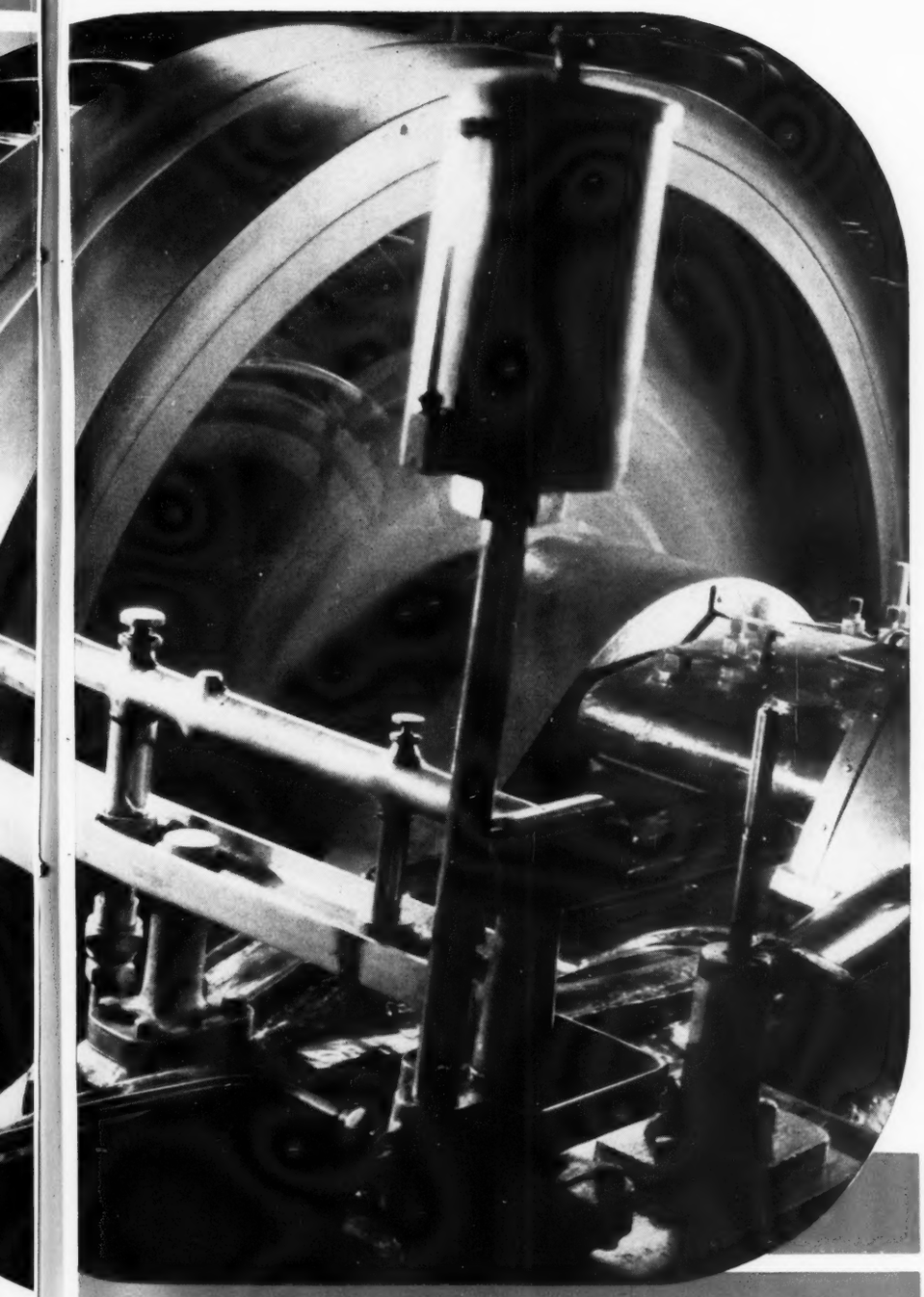
Miscellaneous Bearings

Where the valve gear and governor bearings are lubricated by sight-feed cups, the oil requirements are the same as those outlined for sight-feed cups on main bearings, crank-pins, etc. If they are hand oiled through plain oil holes, a heavier bodied oil will offer less trouble from leakage and reduce the frequency of oiling because heavier oils remain on the bearing surfaces longer.

Enclosed non-releasing Corliss valve gear and Uniflow valve gear are usually lubricated with the same steam cylinder oil as is used for the engine cylinder.

Governors and valve gear are sometimes lubricated with grease applied by means of grease cups or pressure gun fittings. A high quality cup grease of the proper consistency for application through grease cups or by pressure guns, as the case may be, should be used. The grease must be of a character to withstand the temperatures encountered and be free from any tendency to gum or harden.

The selection and use of proper lubricants for steam engine bearings will insure trouble free service of these parts for many years and is an important item to be considered in securing economical plant operation.



LUBRICANTS TO MATCH ALL OPERATING REQUIREMENTS

No one grade of lubricant can effectively lubricate steam engine bearings under all operating conditions. Lubrication requirements vary with different types of equipment and operating conditions. To find the correct lubricants for the particular requirements of their steam engines is one of the problems every power plant engineer must have solved.

For years lubrication engineers from Standard Oil Company (Indiana) have been solving steam engine lubrication problems for power plant executives. There need be no partial solution of any particular problem, no compromise with unusual conditions by Standard engineers. The line of power plant lubricants from which they may choose is complete. There is no lubrication requirement which cannot be met economically with assurance of satisfaction by some Standard Oil lubricant.

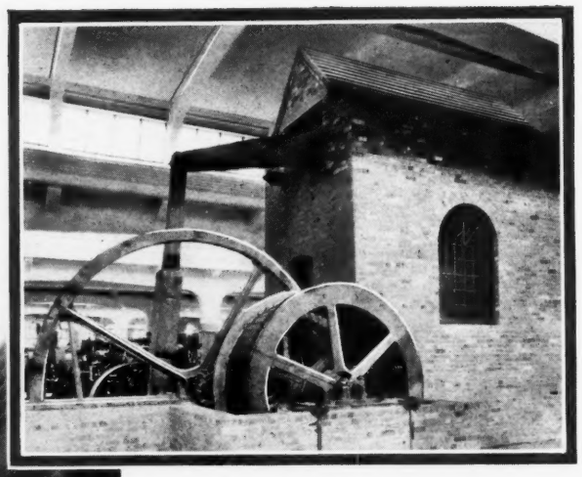
Because of the great possibilities for economies through correct lubrication, it pays to be certain by using Standard Oil Company (Indiana) lubrication service.

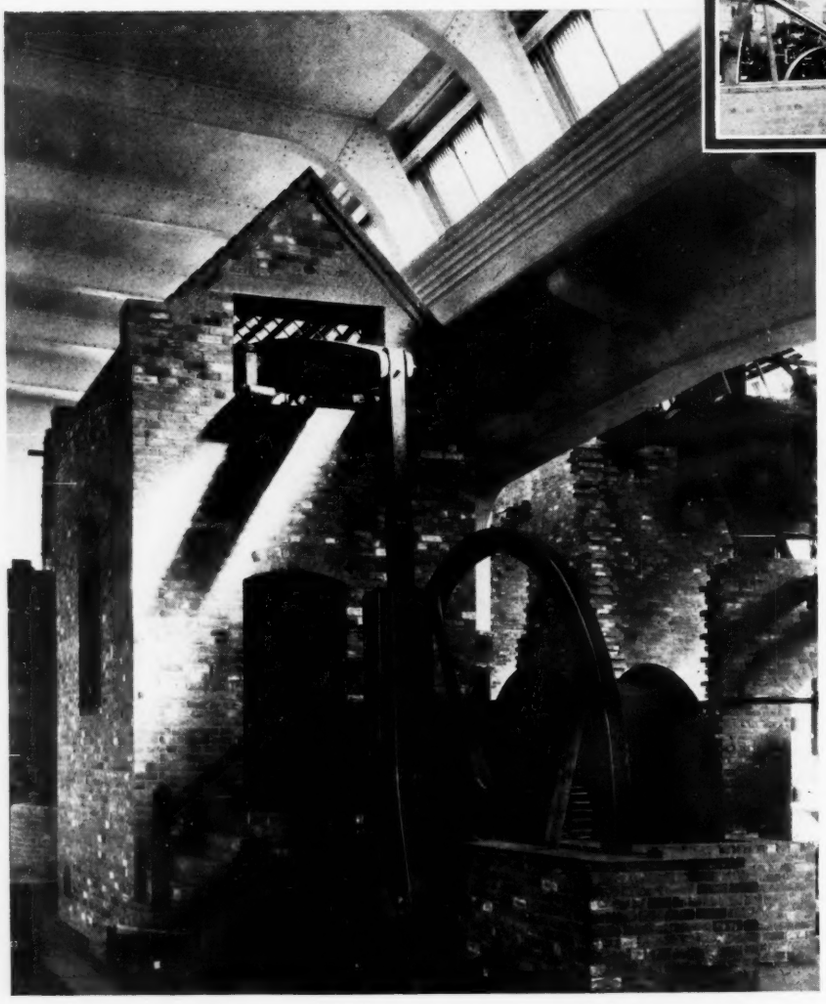
1203

STANDARD OIL COMPANY
(INDIANA)

910 S. MICHIGAN AVE. CHICAGO, ILLINOIS

No. 3—"WINDMILL END" WINDING ENGINE





THIS is an atmospheric engine of the Newcomen type, designed to produce a rotative motion by means of a crank and weighted connecting rod, first introduced by James Pickard of Birmingham, England, in 1780. These engines were extensively used to draw coal up from mines and were called "whims" or "whimsies." Because of their simplicity and low initial cost, they were made and used long after introduction of the more efficient Watt double-acting engine.

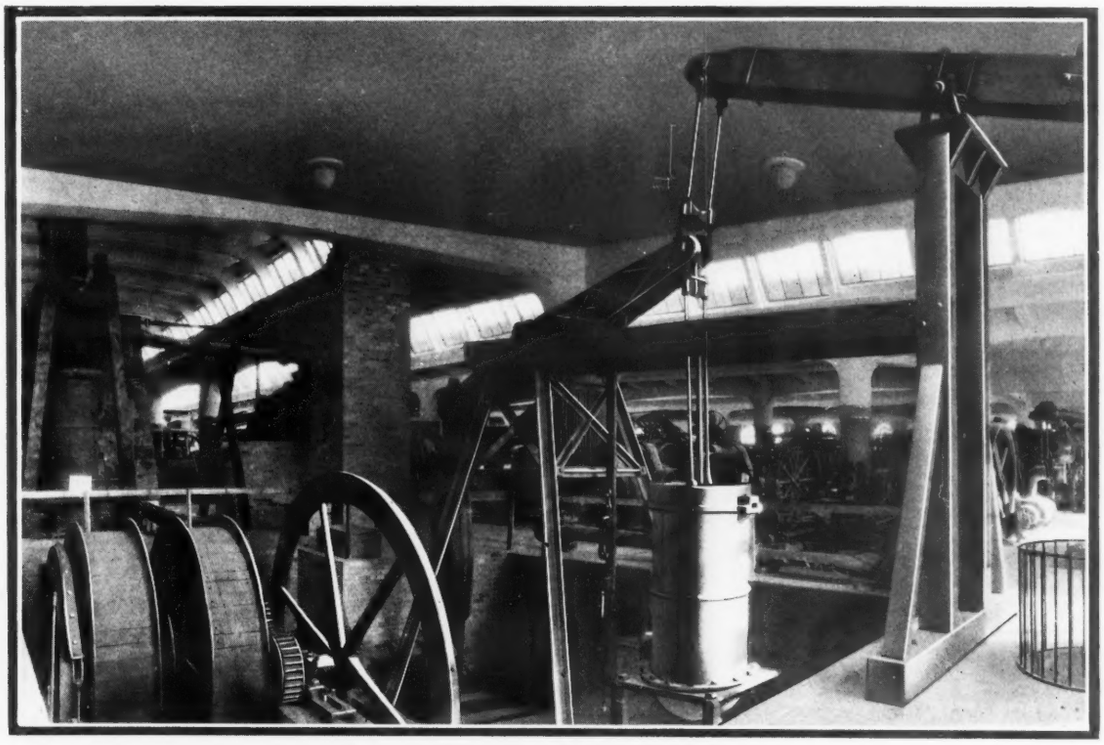
This engine is an original example of the Staffordshire whimsey and was probably made about 1800, but was re-erected in 1831 at the Windmill End station of the Staffordshire Mines Drainage Commission, where it remained in service until 1928, when it was put out of commission by the closing down of many coal mines in that area. It is especially interesting because it possesses a simple separate condenser known from its shape as a "pickle pot." Jet condensation took place in this vessel instead of in the working cylinder, with resultant economies. This "pickle pot" was considered by Watt to be an infringement on his patent of the separate condenser and in many cases was the subject of litigation. The engine has a 28½-in. cylinder, a stroke of 5 ft. When indicated in 1903 the mean pressure was 6.8 lb. per sq.in. and at 30 r.p.m. the engine developed 19.7 i.hp.

The earliest recorded attempt to obtain motive power from steam is that of Hero of Alexandria (A.D. 50), followed by De Caus (1615), Branca (1629), Papin (1690), Savery (1698) and others. The first successful applications, however, came around 1770 when atmospheric engines were used to pump water up to an elevated cistern from which it was discharged to a water wheel, the tailrace of which connected to the lower tank of the engine, thus providing a continuous and steady drive to machinery. This method of obtaining rotary motion, although of low mechanical efficiency, was very smooth running and continued in use in cotton mills long after the introduction of efficient direct-acting steam engines. However, about 1780, atmospheric engines with crank drives began to appear, to be quickly followed by Watt's double-acting expansive rotative engines.

This "Windmill End" engine is probably the last of the "whimsies" to remain in commission. It is remarkable that it survived almost 150 years of mechanical progress and still remained in service.

Obtained in 1930, it was erected in the Edison Museum in 1931. It is shown complete with the engine house erected after the manner which was usual on English coal mines of 100 years ago.

STEAM PLANTS THAT MADE HISTORY



No. 4—THE MOIRA ENGINE

THIS is an atmospheric winding engine of the open-topped Newcomen type, which was first mentioned under James Pickard's patent of 1780. It was extensively used during the last twenty years of the 18th Century to serve coal mines, where the cost of fuel was not an important matter, or by people who could not, or would not, pay the cost of the more efficient but expensive Watt double-acting engine (1784). This type of engine continued to be made as recently as 1820. Few of them have survived until this present time.

This particular engine was taken from the reservoir pit of Moira Colliery Co., Moira, Leicestershire, England, where it was first used when the shaft was sunk in 1864, having previously been used elsewhere on the company's mines. It performed the double duty of pumping and winding, raising men and coal from a depth of about 1,100 ft., and also clearing the workings of 60 gal. of water per min. This reservoir pit is one of the deepest in the locality, and the coal is still hewn by hand. This engine has a bore of 33 in., a stroke of 4 ft. 3 in., and with steam at 2 lb. per sq.in. pressure made about 15 strokes per min. The steam admission and water injection are operated through a simple rack and pinion worked by the plug rod, and the valves are of the mushroom type. Injection is by force pump, and the shifting valve is situated on the eduction box. The main beam is cast iron and bears the date 1821, but the pump beam is of wood and the flywheel a very old type open casting, therefore it is possible that the engine was made prior to 1800.

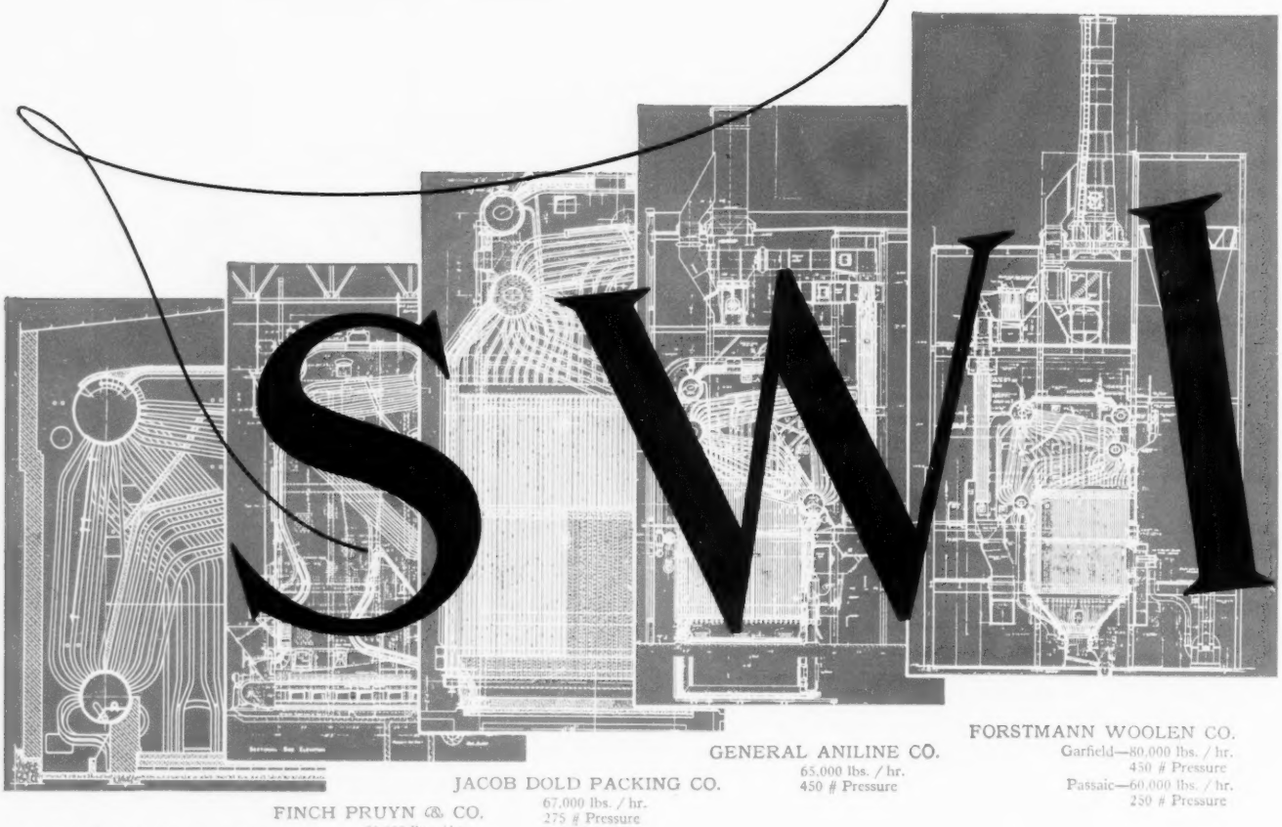
It worked as a pumping engine until 1929, in which year it was acquired by Henry Ford. It was erected at Edison Institute in 1931. Steam for this engine was raised from pit-head waste. It was attended by a boy, and its owners claimed that under these conditions it was, despite its age, still a most economical proposition from their point of view. Only the fact that it was to be honorably preserved tempted them to part with it.

The Moira Collieries, from which this engine was obtained, are near the village of Moira in the County of Leicestershire, England, and are about 10 miles from the City of Burton-on-Trent. They are upon the estates of the Marquis of Hastings, whose family name is Moira, and form part of one of the largest of English coal fields. With the exception of the pit once served by this old engine, all the mines have been modernized.

In connection with the Moira Collieries (coal mines) there existed until 1847 a foundry called the Moira furnaces. During the Luddite riots (1811-1816) the then Marquis of Hastings, hearing of the approach of the rioters, hurriedly cast some cannon at this foundry. He also armed his miners with long staves resembling pikes and drew them up in military formation. When the Luddites arrived and saw the Marquis' men, they imagined that some regular force awaited them and withdrew without carrying out their intention of destroying the machinery of the foundry and mines. Some of the cannon were still in existence when this engine was dismantled, and may still remain.

STEAM PLANTS THAT MADE HISTORY

have you also noticed
THE VERY DEFINITE



A Few Companies who have Swung to Riley Units

W. Va. Pulp & Paper Co.	Covington, Va.
W. Va. Pulp & Paper Co.	Piedmont, W. Va.
Kalamazoo Vegetable Parchment Co.	
Pennsylvania Sugar Co.	Philadelphia, Pa.
Continental Distilling Co.	Philadelphia, Pa.
General Aniline Co.	Grasselli, N. J.
Forstmann Woolen Co.	Garfield, N. J.
Forstmann Woolen Co.	Passaic, N. J.
Columbia University	New York City
Hamilton Woolen Co.	Southbridge, Mass.
Finch Pruyn & Co.	Glens Falls, N. Y.
Jacob Dold Packing Co.	Buffalo, N. Y.
American Oak Leather Co.	Louisville, Ky.
Monroe Silk Mills	Stroudsburg, Pa.
Aberfoyle Mfg. Co.	Chester, Pa.
Sunbury Converting Works	Belvidere, N. J.
Sunbury Converting Works	Sunbury, Pa.
Atwater Kent Mfg. Co.	Philadelphia, Pa.
Harnischfeger Corp.	Milwaukee, Wis.
Otter Tail Power Co. 3 plants	
Hoskins-Marainville Paper Co.	Menominee, Mich.
Franklin Heating Station	Rochester, Minn.

You have undoubtedly noticed that Riley Equipment has been selected for a large percentage of the recent installations of modern steam generating equipment. You are not interested so much in the fact that there has been a very definite swing to Riley Equipment as in the reason for the rapidly growing preference for this equipment.

A visit to any of the many modern installations of Riley Steam Generating Units will give you the reason why so many plants have selected and preferred Riley Equipment. You will find outstanding performance . . . extreme economies . . . trouble-free operation . . . uninterrupted service . . . minimum of maintenance . . . absolute satisfaction. Such capable performance and reliability, at all times and under all conditions, reflect the quality that has been built into these units.

You will also be impressed with the excellence of the general layout, design, appearance and completeness of the units . . . evidence of the competent and sound engineering skill back of these

to RILEY *steam generating* EQUIPMENT

units. As Riley manufactures all of the elements making up the complete unit, you will find each element properly co-ordinated and proportioned to the complete unit to give maximum economy and satisfaction.

When you consider modernizing your boiler plant, be sure to consult a Riley engineer. He is well qualified to assist you in selecting the size and type of equipment best suited to your needs. Co-operation with you is our business. You can purchase the complete unit from Riley under one contract without division of responsibility.

RILEY STOKER CORPORATION

WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST. LOUIS CINCINNATI HOUSTON
CHICAGO ST. PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER ATLANTA EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

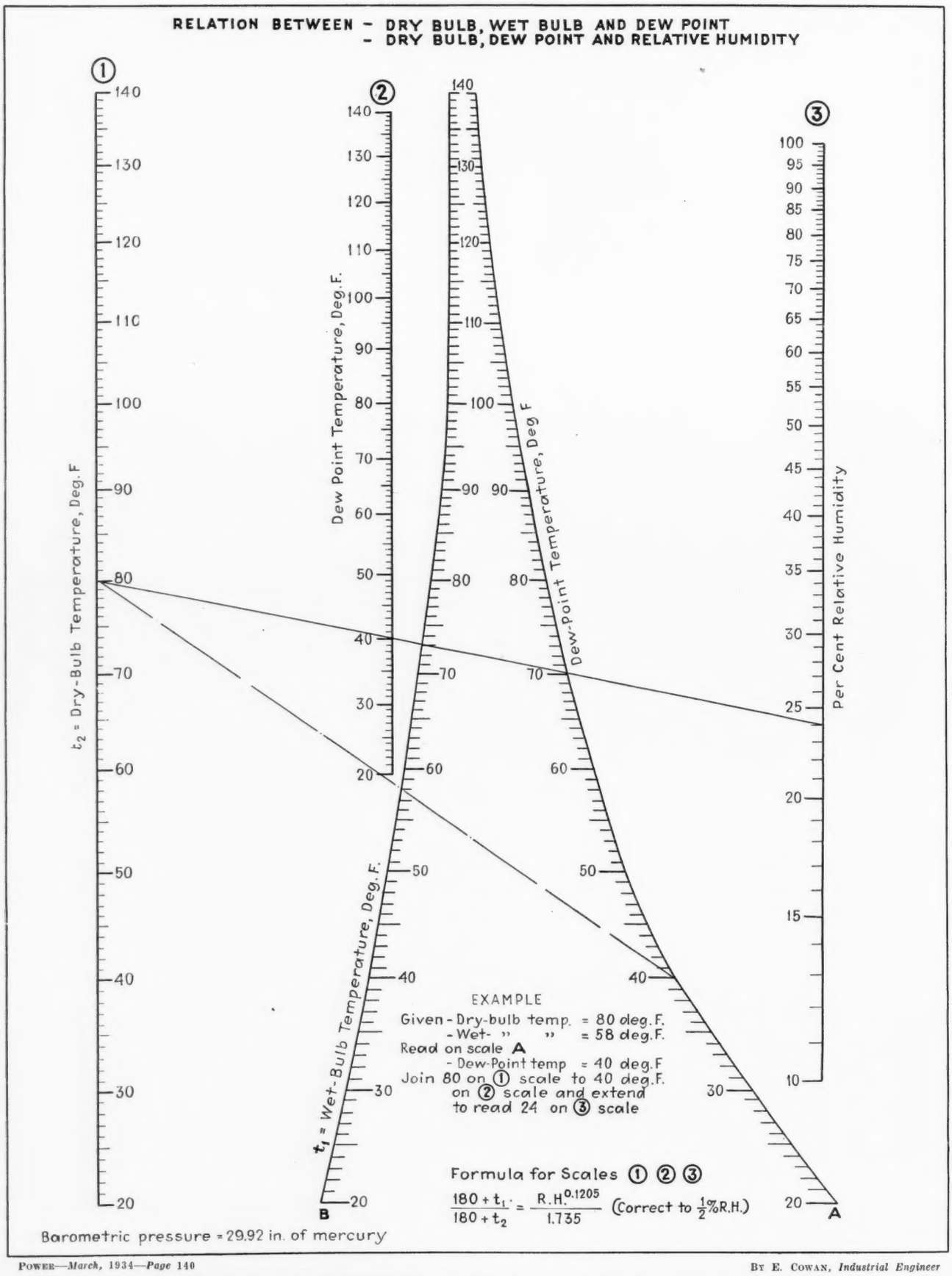
Riley Stoker Co., Ltd., London — **Feuerungsanlagen Aktiengesellschaft, Germany**
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia — **Andersen-Meyer & Co., China**
International Machinery Co., (W. R. Grace Co.,) South America — **American Trading Co., Japan**

COMPLETE STEAM GENERATING UNITS

BOILERS • SUPERHEATERS • AIR HEATERS • ECONOMIZERS • PULVERIZERS
STOKERS • WATER COOLED FURNACES • SETTINGS • FLUE GAS SCRUBBERS

Number 19

Psychrometric Chart

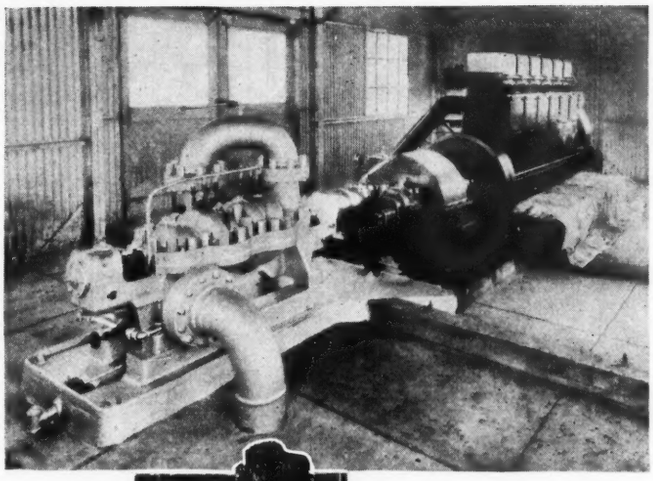

RELATION BETWEEN - DRY BULB, WET BULB AND DEW POINT
- DRY BULB, DEW POINT AND RELATIVE HUMIDITY
①
②
③
t_2 = Dry-Bulb Temperature, Deg. F
Dew Point Temperature, Deg. F.
Dew-Point Temperature, Deg F
Per Cent Relative Humidity
t_1 = Wet-Bulb Temperature, Deg. F.
B
A
EXAMPLE
Given - Dry-bulb temp. = 80 deg. F.
- Wet- " " = 58 deg. F.
Read on scale A
- Dew-Point temp = 40 deg. F
Join 80 on ① scale to 40 deg. F. on ② scale and extend to read 24 on ③ scale
Formula for Scales ① ② ③
$\frac{180 + t_1}{180 + t_2} = \frac{R.H.^{0.1205}}{1.735}$ (Correct to ½%R.H.)
Barometric pressure = 29.92 in. of mercury

POWER—*March*, 1934—*Page* 140

By E. Cowan, *Industrial Engineer*

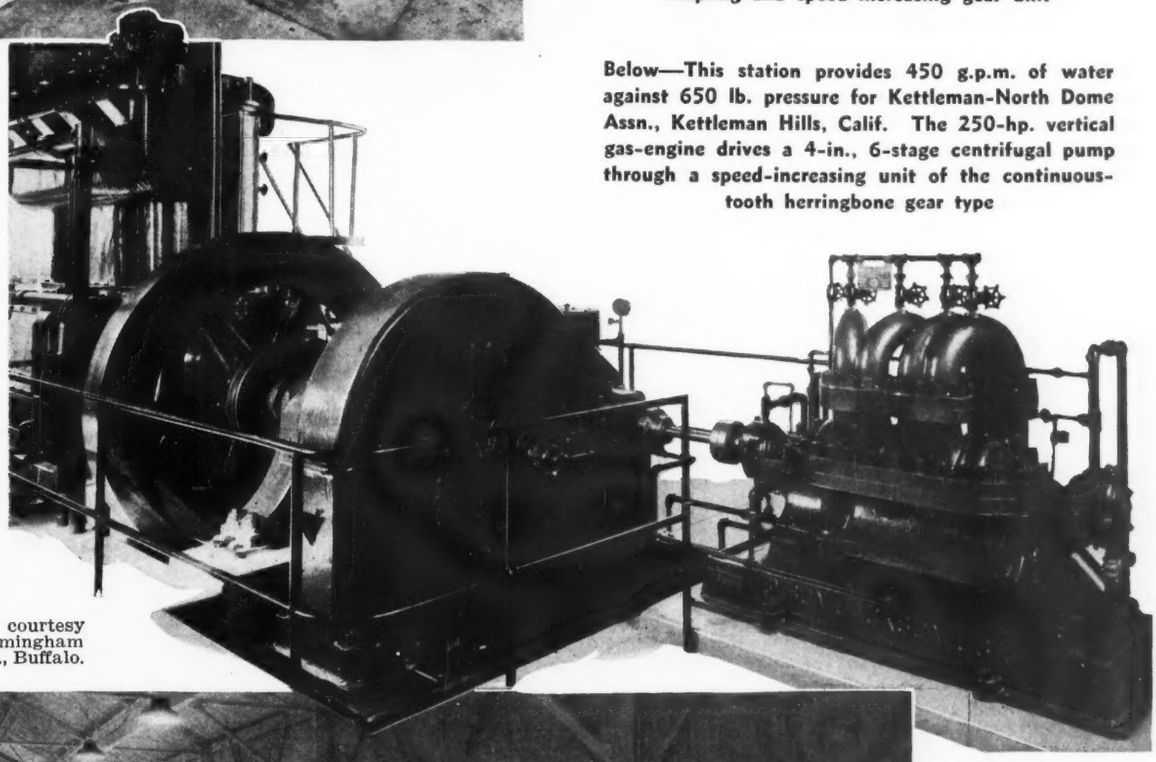
© POWER

GEARED PUMPS

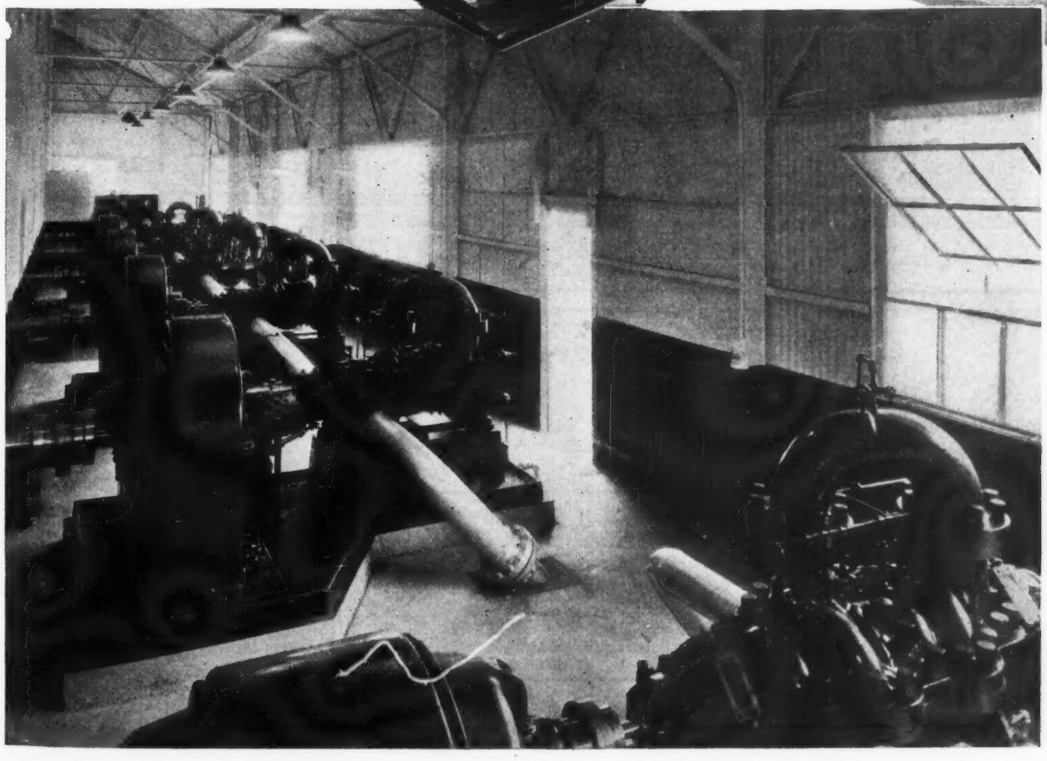


Left—A 750-r.p.m. diesel, one of the highest-speed units so far installed, drives a high-pressure pipe line centrifugal pump for Stanolind Pipe Line Company at Mexia, Tex. It is connected through a flexible coupling and speed-increasing gear unit

Below—This station provides 450 g.p.m. of water against 650 lb. pressure for Kettleman-North Dome Assn., Kettleman Hills, Calif. The 250-hp. vertical gas-engine drives a 4-in., 6-stage centrifugal pump through a speed-increasing unit of the continuous-tooth herringbone gear type



Photographs courtesy Farrel - Birmingham Company, Inc., Buffalo.



Five 250-hp. gas engines within the building at left drive centrifugal pumps through couplings and speed increasers for Phillips Petroleum Company at Oklahoma City. A motor-driven standby unit appears in the foreground

SAFETY with DIESELS

By V. L. MALEEV*
Professor of Mech. Engrg., Oklahoma A&M College

TRUE safety includes three protective elements: operators against injury, machinery against damage, and the whole plant against fire. To protect men, the following points should be taken care of:

Engine platform and stairs should be of slip-proof steel or cast-iron plates with checkered or diamond surface. If the platform is more than 2 ft. above the floor, a strong railing should be provided all around it. Stairs should also be slip-proof, with handrails on both sides.

Flywheels, pulleys and belts should be guarded. Guards for flywheels should be of not less than 1¼-in. standard pipe or of angle iron not smaller than 2x2¼ in., supported on uprights of at least equal dimensions. Uprights should be spaced not more than 8 ft. apart. Pipes can be connected either by standard tees and crosses or by special railing fittings; in either case fittings should be counterbored so that they cover the pipe threads about ¼ in. Railings may also be assembled by welding. Uprights are either screwed into floor flanges or set into 1-ft. pieces of pipe of the next larger size, grouted into the floor. Standard railings extend 42 in. above floor level, and are stronger if a center rail is set in 21 in. above the floor. When a flywheel extends into a pit, a toe board should be provided about 4 in. high around the pit edges, of either concrete or metal. A toe board is also advisable on the coming-down side of a flywheel if it is closer than 12 in. to the floor.

Pulleys and belts can be protected by a standard railing if it can be placed with a clearance of not less than 15 in. and not more than 20. If clearance is less, a complete enclosure to a height of 6 ft. should be provided, of either pipe or angle iron with heavy wire screen filling in. The screen may be fastened by welding, by a cover strip screwed to the support, or by clips encircling the support and bolted to the screen.

Gears, sprockets and chains should be similarly enclosed, except that sheet iron is substituted for the coarse screen to act as an oil guard.

Coupl ngs and set collars should not have projecting parts, bolts or nuts. Gib-head keys should be covered by sheet iron or wooden rings, even if inside a standard guard. Set-screw heads on revolving parts should be protected by smooth cylindrical projections such as safety collars, or should have flush or countersunk heads.

Hazards connected with servicing cannot be eliminated entirely but can be lessened by proper instructions and warnings conspicuously posted.

The engines should be protected by warning devices which call the operator's attention when something is wrong or by automatic controls which stop the engine as soon as a given operating condition becomes abnormal. Warnings, alarms or indicators should be installed to call attention to the following conditions: improper temperature or quantity of cooling water; improper pressure, temperature or viscosity of lubricating oil; excessive bearing temperature; improper exhaust gas temperature. Automatic controls should be added to stop the engine in case of: lack of cooling water, lack of lubricating-oil pressure, excessive engine speed, excessive load, high water temperature.

Thermometers should be installed in the water discharge pipe near each cylinder to prevent operation with either excessively hot or excessively cold water. It is convenient to have special thermometers which ring an alarm bell when the temperature reaches a certain height. Glass thermometers break easily, therefore metal thermometers are preferable.

Water flow may be seen from a flowmeter of the type shown in Fig. 1, in which spring **d** closes swing check **c** if flow stops; **a** and **b** connect to an electric alarm bell. A simple means of watching both temperature and amount of cooling water is to discharge it from the engine into a funnel-topped pipe.

Lubricating oil pressure is indicated by a pressure gage and its temperature by thermometers or thermocouples connected to the same millivoltmeter as the instruments showing cooling water temperature. Lubricating oil viscosity can be read directly and watched constantly by means of an automatic viscosimeter, called by its makers "Lubri-guide" or "Lubri-meter." This unit consists essentially of a pressure gage which indicates the head set up by oil flowing through a friction tube. Rate of oil flow is held constant regardless of oil pressure by a unit like a reducing valve.

A new method of watching the temperature of metal surfaces (as in the end or outboard bearings) is based on the change of color of several iodine salts—CuJ, HgJ_2, AgJ and double salts of these compounds. One double salt, $Cu_2J_2 + HgJ_2$, is scarlet red below 140 deg. F. and changes to chocolate brown between 140 and 160 deg. The double salt $AgJ + HgJ_2$ is light yellow up to 195 deg. F. and turns vivid carmine red between 195 and 212 deg. A mixture of 25 per cent CuJ and 75 per cent HgJ_2 changes from cinnabar red to black. In each case, when the temperature returns to the lower value, the color changes back again. These salts are applied finely ground by mixing with linseed oil as a regular oil paint, then are covered by a coat of transparent lacquer.

Exhaust temperatures should be observed by pyrometers or thermocouples in the exhaust elbows of each cylinder.

*Formerly chief engineer, Western-Enterprise Engine Co., Los Angeles, Calif.

Additional Gas-Engine Plants Installed in

Owner	Location	Service	Engine Builder	Horsepower	No. Engines	No. Cyl.	Cyl. Bore, In.	Cyl. Stroke, In.	R.P.M.	Single or Tandem	Horizontal or Vertical	Fuel Consumption B.t.u. per Hp.-Hr.	Type of Fuel	B.t.u. per Cu. Ft. of Fuel
Panhandle Eastern Pipe Line Co.....	Liberal, Kans.....	Gas Comp.	C.B.	1,000	5	4	21½	36	125	T.T.D.	H	10,000	Natural	1,020
Panhandle Eastern Pipe Line Co.....	Louisburg, Kans....	Gas Comp.	C.B.	1,000	5	4	21½	36	125	T.T.D.	H	10,000	Natural	1,020
Panhandle Eastern Pipe Line Co.....	Glenarm, Ill.....	Gas Comp.	C.B.	1,000	4	4	21½	36	125	T.T.D.	H	10,000	Natural	1,020
United Gas Public Service Co.....	Latex, Tex.....	Gas Comp.	C. & G.	1,000	8	4	21½	36	95–125	T.T.D.	H	12,200	Natural	992 av.
Phillips Natural Gas Co.....	Pampa, Tex.....	Gas Pump	Worth	700	16	4	18½	20	200	T.	H	10,000	Natural	1,050
Tulsa Ice Co.....	Tulsa, Okla.....	Power Pl.	Clark	240	3	8	9	11	450	S.	V	10,500	Natural	1,050
Panhandle Eastern Pipe Line Co.....	Dodson, Mo.....	Gas Comp.	C.B.	180	1	..	..	..	180	T.S.	H	10,000	Natural	960
				90	1	..	..	..	180	S.	H	10,000	Natural	960
Panhandle Eastern Pipe Line Co.....	Paola, Kans.....	Gas Comp	Sup.	185	3	2	18½	20	185	T.S.	H	10,000	Natural	960
Panhandle Eastern Pipe Line Co.....	Stilwell, Kans.....	Gas Comp	Sup.	185	3	2	18½	20	185	T.S.	H	10,000	Natural	960

Abbreviations
Comp. —Compressor
T.T.D.—Twin-tandem, double-acting
T.S. —Twin single
T. —Tandem
S. —Single
H. —Horizontal
V. —Vertical
Res. —Reservoir
Str. —Stream
Zeo. —Zeolite
G. —Gas engines
C.B. —Cooper-Bessemer Corp.
C. & G.—C. & G. Cooper

These temperatures serve mainly to aid in adjusting fuel injection in all cylinders to obtain even load distribution. Color of exhaust is a useful warning.

Automatic devices which stop an oil engine when operating conditions become unsafe can be divided into two classes: those shutting off fuel supply and those closing a valve in the air-intake pipe. Devices of the first type are smaller and cheaper; those of the second have more positive action.

Fig. 2 diagrams an interlocked lubricating oil and fuel system which automatically shuts the engine down in case of lubricating oil failure. The automatic device consists of a cylinder with lubricating-oil pressure on the right-side of a piston compressing a helical spring on the left side. The piston rod controls the suction valve of the fuel-injection pump. When lubrication pressure drops too low, the spring moves the piston to the right, thus opening the fuel suction valve, putting the pump out of service and stopping the engine. Obviously, the engine cannot be started originally until lubrication pressure is brought to a certain height by hand pumping, thus avoiding lubricating difficulties during the starting period. A similar device, but larger because of lower pressures, is used to stop the engine in case of cooling water failure.

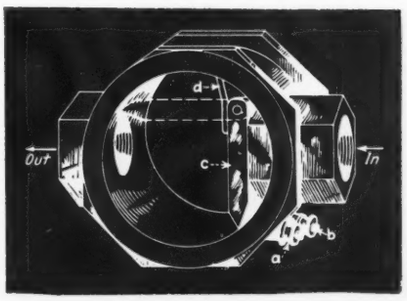
Fig. 2 also shows two independent lubricating pumps, one driven by the engine, the other by an electric motor. The pumps operate in parallel, delivering oil into the same header, excess oil being bypassed. Each pump is large enough to handle the load alone.

One device to stop an engine when its speed exceeds a preset maximum consists of a small weight set in a recess in the flywheel rim and held in position by a spring. When speed increases beyond the set limit, centrifugal force causes the weight to project from the rim and strike the end of a lever. Movement of the lever trips a weight which opens a bypass valve in the fuel line.

Devices which act upon the air intake are basically mercoid switches which close electrical circuits through the action of Bourdon-type pressure gages when lubricating oil or cooling water drops below a given limit. The overspeed device consists of a mercoid switch rotating with the engine shaft. When speed becomes excessive, the mercury is thrown into the far end of the tube, closing an electro-motor circuit and tripping the shut-off valve in the intake-air line. The same switch also flashes a red light and sounds a warning horn. Time between closing of the circuit and tripping of the shut-off valve can be varied from zero to 10 min., thus giving the operator time to correct the condition. If corrected in time, the engine does not stop.

Automatic regulation of cooling water temperature should also be mentioned. This is used if water is being recirculated and an additional supply of colder water is available. If the temperature of the water leaving the engine exceeds a certain limit, sensitive element **a**, Fig. 3, begins to open regulating valve **b**, to admit a given amount of colder water. Swing check valve **c** prevents the high-pressure cold water from backing up into the cooling-tower line. Should normal water supply fail entirely, the temperature rise in the discharge line opens valve **b**, check-valve **c** closes, and cooling of the engine will be taken over by the auxiliary cold-water connection.

Fig. 1—Flow indicator



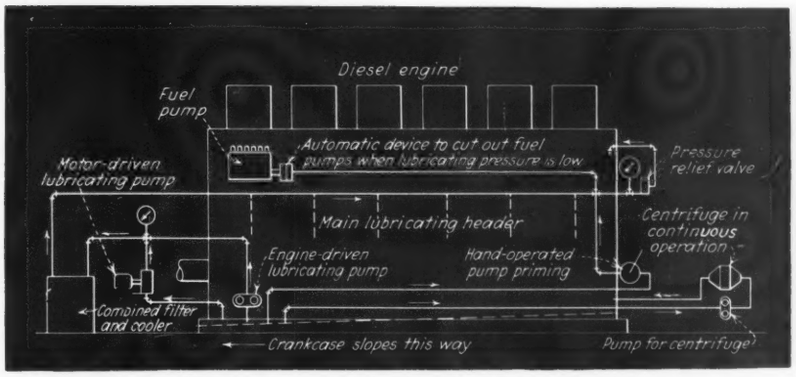
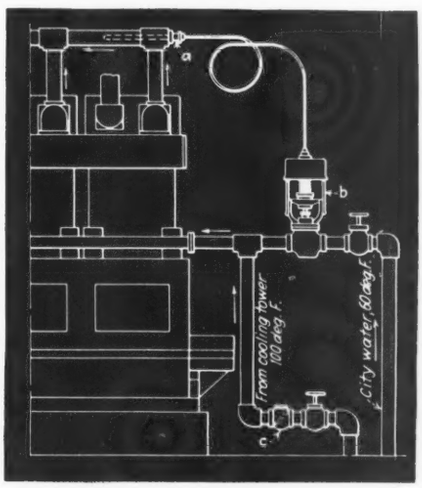


Fig. 2—Safety arrangements in a diesel lubricating system

Fig. 3—Automatic water-temperature regulator



the United States During the Past Year

Compiled by E. J. TANGERMAN
Assistant Editor

Air Cleaner or Washer	Gas Cleaner or Scrubber	Lubrication Oil Cleaner	Oil Consumption, Rated Hp.-Hr. per Gal.	Cooling Water Source	Type of System	Water Inlet & Outlet Temp., deg. F.	Exhaust Temp., deg F.	Muffler	Other Prime Mover	Waste Heat Utilized	Remarks
Cleaner	.....	Filter	2,000	Wells	Tower	32–75 & 120–140	.....	Yes	360G	No	1,250 g.p.m. water circulated at full load, av.
No	.....	Filter	2,000	Res.	Pond	40–80 & 120–140	.....	Yes	360G	No	Old engines are 190-hp., 3-cycl., C.B., V.
No	.....	Filter	2,000	Wells & Str.	Tower	40–80 & 120–140	.....	Yes	360G	No	1,000 g.p.m. water circulated at full load, av.
No	.....	Filt. & Circ.	2,860	Wells	Zeo. & Tower	86–130	900–1,100	Yes	270G	Heating	Three 90-hp. S.A. gas driving 60-kw. gen.
Cleaner	.....	Filter	4,000	Wells	Zeo. & Tower	80–130	300	Yes	No	No	4,000 g.p.m. water circulated at full load.
No	.....	Filter	2,880	City	Pond	65–130	.....	Yes	No	No	For ice manufacturing 200 g.p.m. water elec.
No	.....	No	1,500	Str.	Tower	40–90 &	.....	Yes	Gas (very	No	75 g.p.m. water circ. One of 4 stations for
No	.....	No	1,500	Str.	Tower	120–140	.....	Yes	small)		shallow sand and shale gas, Kansas City.
No	.....	No	1,500	Str.	Tower	40–90 & 120–140	.....	Yes	Small gas	No	As above, 140 g.p.m. water circulated.
No	.....	No	1,500	Res.	Tower	40–90 & 120–140	.....	Yes	75G	No	As above. Small unit is 1-cycl. sup. H. driving 50-kva. alternator.

Worth.—Worthington Pump & Machry. Corp.
Clark —Clark Bros. Co.
Sup. —National-Superior Co.

Data on the above plants was received after publication of the table in the January, 1934 number of *Power* on pages 19 and 20. The information on these additional 49 engines will make a valuable addition to the previous table.—Editor.

PRACTICAL AIDS TO OPERATION

Auxiliary Oil Burner Saves Fuel

IN THESE TIMES, economical and efficient building operation is essential—and one of the major costs is fuel for heating. The Central Building, in Seattle, Wash., is equipped with a marine type double-furnaced boiler having 1,200 sq.ft. of heating surface and operating at 4 to 6 lb. pressure, supplying steam for building heating only. Each furnace has one burner, using 15-deg. Bé fuel oil at 20 lb. pressure and 130 deg. F.

The boiler is on from 6 A.M. to 5 P.M. In past years, it had been necessary to cut in a small boiler at 5 P.M. to carry the evening load. This operating routine resulted in an average evaporation of about 9 lb. for the two boilers, and trouble with the large boiler due to cooling down over night.

This year we installed a small auxiliary rotary burner in the side of one of the furnaces of the main boiler. An extension tip was constructed to go through the side wall. The burner was placed about one-third of the way back from the front of the furnace, just outside the combustion cone of the main burner.

In cold weather, the auxiliary burner is cut in at 5 P.M. and off at 7 P.M., and in mild weather it may go on at 10 A.M. and run until 7 P.M., cutting off the main burners.

Use of the auxiliary burner for light loads conserves and holds heat in the main boiler setting, saves oil, and the average evaporation of the plant is now between 12 and 15 lb. The small boiler is used only for stand-by service.

Seattle, Wash. CHARLES H. CHURCHILL

Recording Thermometer Used As a Back-Pressure Valve Indicator

THE back-pressure valve on the exhaust line is usually located so far from the engine room, particularly in hotels and office buildings, that it is not known when the valve is open or closed. At the St. George Hotel, Brooklyn, N. Y., this difficulty has been overcome by installing a thermometer in the exhaust pipe just beyond the back-pressure valve. This thermometer is connected to a recorder in the chief engineer's office, where a record is made of the temperature outside the back-pressure valve.

In the heating season when all the exhaust steam is used, the back-pressure valve should remain closed at all times and the thermometer give a minimum reading, Fig. 1. On the other hand, in warm weather when the heating load is light and there is an excess of exhaust steam, the back-pressure valve will remain open all the time; this will be shown on the chart as in Fig. 2. A combination of the two conditions is shown in Fig. 3. From about 5 to 11 P.M. there is an excess of exhaust steam because of the heavy power load. For the remainder of the day the back-pressure valve remains closed. If the valve did not seat properly, this would be indicated by a record between minimum and maximum.

The chart, Fig. 1, shows that in the winter months the power and heating loads synchronize; at no time during the day is there an excess of exhaust steam. This is true for about seven months of the year. In the summer months there is an excess of exhaust practically all the time, while during the marginal periods between summer and winter there are times when all exhaust is used and at others there is an excess. However, very seldom is live steam required for the heating load at one time of the day and at another an excess of exhaust occurs.

Brooklyn, N. Y. JOHN A. SETHER
Chief Engineer, St. George Hotel

How Some Centrifugal-Pump Troubles Were Corrected

SEVERAL YEARS AGO, I had occasion to investigate the performance of a particularly noisy centrifugal pump in a large apartment house. When I checked the conditions under which the pump was operating against characteristic curves submitted by the pump manufacturer, I found the actual head considerably less than that for which the pump had been designed. This resulted in higher velocity through the discharge piping and consequent noisy operation.

To eliminate the noise, I reduced impeller diameter so that the pump delivered the volume of water for which the system had been laid out. Power consumption was reduced and more efficient pump operation obtained. In most cases, a noisy pump is operating inefficiently, an efficient pump quietly.

In another instance, the pump was also noisy, but operating conditions checked with the manufacturer's test curves. Alignment was carefully checked, but

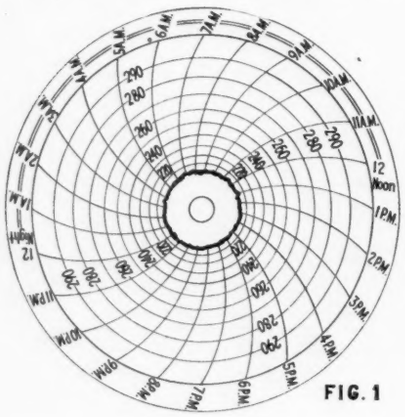


FIG. 1

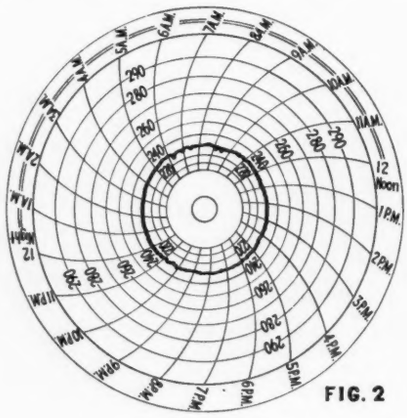


FIG. 2

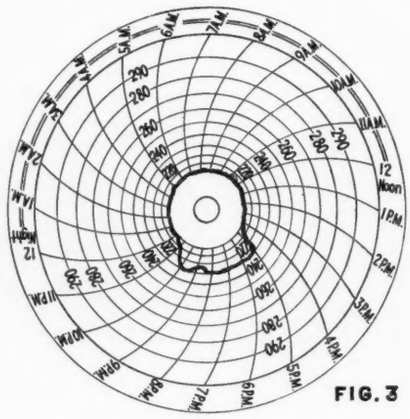


FIG. 3

showed no cause of trouble. After several tests had proved of no avail, we decided to remove the pump and send it back to the factory. A mechanic was called to remove the unit. When flange bolts between pump and discharge piping were removed, the flanges separated about $\frac{1}{8}$ in., showing that the piping had not been lined up properly with the pump. Correcting this condition eliminated the noise. Thus, an expensive trouble job was the result of an improperly installed pumping unit. A peculiar thing about the misalignment was that the noise and vibration was telegraphed through the standpipe into the upper floors of the building.

Sometimes troubles occur which are more difficult to locate and correct than either of the two mentioned. In a large industrial plant, a new Underwriters fire pump of an approved make was installed and ready for official test by the inspector. The pump was rated 1,500 g.p.m. against 100-lb. pressure, but it would not deliver more than 1,100 g.p.m. at the first test and with each succeeding test the capacity dropped. This indicated a suction-line leak, but the customer insisted that the line was tight and the trouble must be in the pump. The suction line was about 200 ft. long, placed 6 ft. underground. After considerable discussion it was decided to dig up this line, with the understanding that if the suction line was not responsible for the trouble the pump manufacturer would stand the expense of the work. After the fill had been removed, it was found that the line had no leaks, but it had a considerable hump which provided an air trap and cut down its capacity. When this was corrected, the pump met its test conditions satisfactorily.

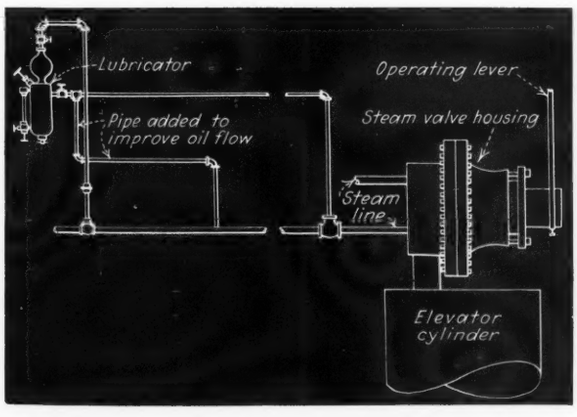
There are probably many pumps that are not operating at their best efficiencies for the conditions, but as long as they deliver water, the user is satisfied. It is unfortunate that this should be so, when a slight change may result in greatly increased operating efficiency.

New York City FRANK A. KRISTAL
Mechanical Engineer.

Improved Hydrostatic-Lubricator Operation in Cold Weather

A STEAM-CYLINDER-OPERATED elevator was located in an unheated isolated part of an industrial building. For convenience, the lubricator for the steam valves was mounted some distance away from the elevator mechanism. It was found that in cold weather the oil congealed in the feed line from the lubricator to the steam valves and would not flow satisfactorily.

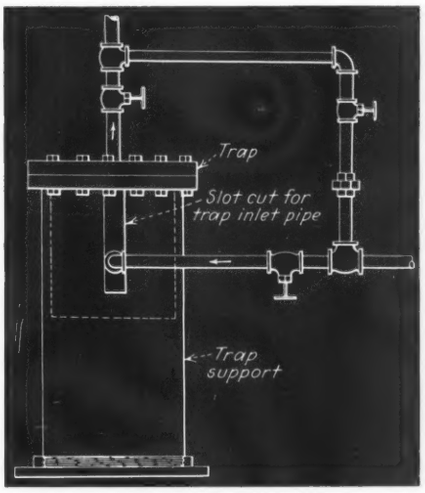
This difficulty was reduced by connecting a $\frac{1}{2}$-in. pipe from the feed line just off the lubricator into the steam main about 15 ft. from the lubricator steam tap, as in the figure. Because of friction loss, there was several pounds pressure difference in the steam main between the two $\frac{1}{2}$-in. connections each time the elevator was operated. This pressure differential served to establish an oil flow each time the steam valve in the elevator opened. Also, there was a slight pressure drop between the pressure line to the lubricator and the new $\frac{1}{2}$-in. line installed. This prevented the pressure from backing up through the lubricator and interfering with proper operation.



Waterville, Me. HARRY M. SPRING, JR.

Easily Made Support for Inverted Bucket Traps

AN EASILY MADE stand for traps of the inverted-bucket type, or of similar outside construction, may be made as shown in the diagram. A short length of pipe having an inside diameter slightly larger than the trap body is



secured to the floor with a flange. With a hacksaw or cutting torch, a slot, a little wider than the inlet pipe diameter, is cut in the side of the trap support. When the trap is set in this support, the flanges will rest on the top of the pipe.

Such a mounting prevents leaks in the pipe lines either from expansion and contraction or from the weight of the trap being supported by the piping.

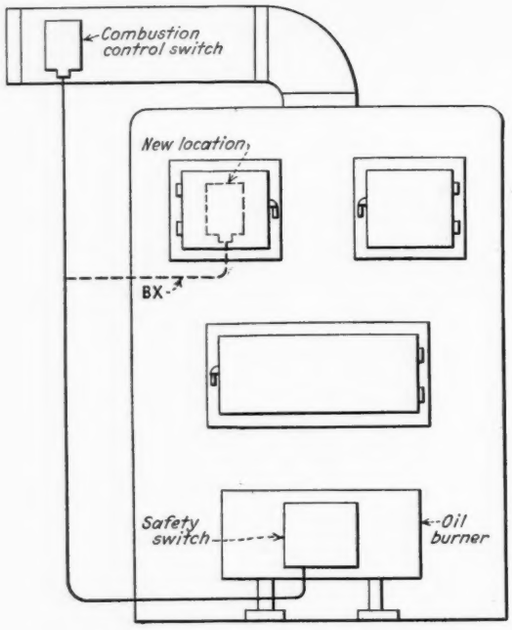
Boston, Mass. C. A. ARMSTRONG

Relocation of Combustion Switch Cures Oil-Burner Trouble

FULL-AUTOMATIC operation of an oil burner on a heating boiler, after one year's service, caused considerable trouble. The safety switch would have to be manually reset one or more times daily and automatic night operation was out of the question. The trouble was traced to a lag in the combustion control switch in the stack. This switch was adjusted to the limit, then the heat element was removed and thoroughly cleaned, but when replaced was not dependable. A new element was put in the switch, and this also was erratic.

It was decided to put the combustion-control switch in one of the boiler passes, as indicated by dotted lines in the figure, that it might be actuated more quickly. When this was done, the trouble was eliminated.

Before the change was made it was reasoned that



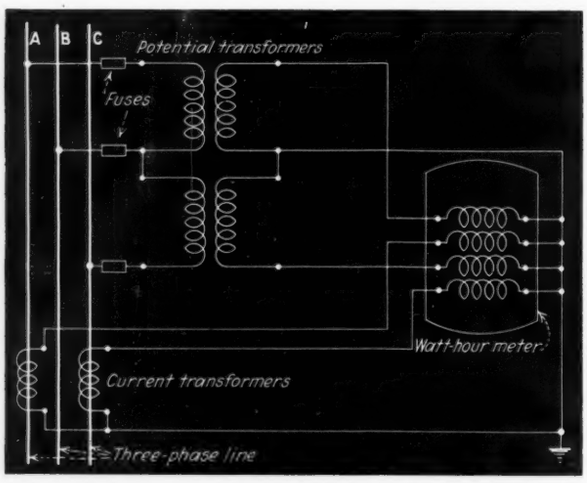
when over half of the radiator was shut off, as in mild weather (when most of the trouble occurred), the burner operating periods occurred at long intervals. When the thermostat did call for heat and the boiler burner responded, the heat absorption of the boiler was too great to allow sufficient rise in stack temperature to actuate the combustion control switch before the safety switch tripped out. The change in position of the combustion switch cured the trouble.

Brooklyn, N. Y. A. ANDERSON

Weak Magnets Cause Wattmeter to Over-Register

FOR ABOUT two years, the power supplied to a 13,200-volt, 3-phase distribution line increased. No reason could be found for this increase, as there was little change in the connected load. The meter was connected as in the diagram. Investigation over several months failed to reveal any of the usual causes for a watt-hour meter registering too fast. As a last resort, a new set of retarding magnets were obtained and substituted for those on the meter. The meter was then tested and found to be within one per cent accurate and the meter readings became normal.

Guthrie, Okla. V. K. STANLEY



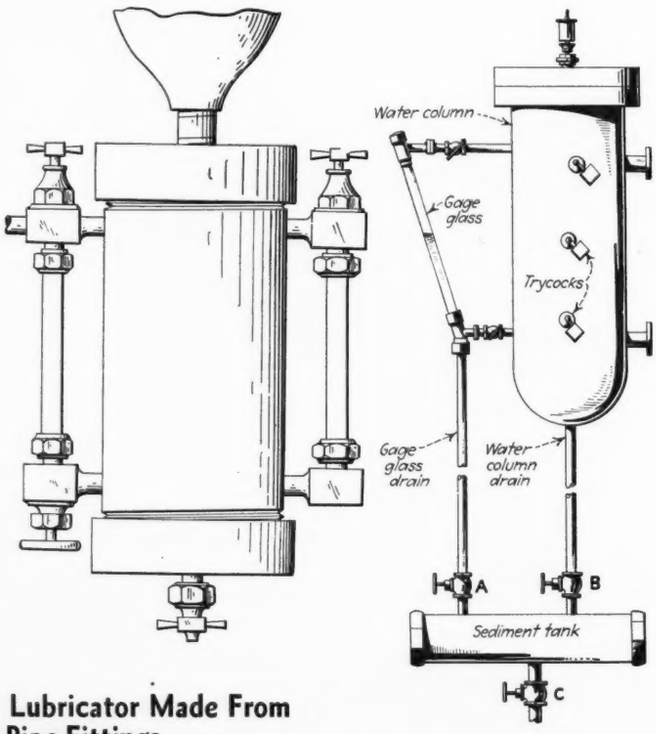
Installs Sediment Tank to Prevent Gage-Glass Blowouts

GOOD operating routine makes it advisable to blow down boiler gage glasses and water columns about three times or more every 24 hr. This prevents an accumulation of suspended scale or sludge which might block steam or water connections. The sudden temperature change accompanying blowdown of a gage glass is responsible for most of the failures.

At one plant where much trouble was experienced with gage-glass failures, a small sediment tank was installed, as below on right. Valves *A* and *B* are normally open, while valve *C* is closed. When it is desired to blow down the column and glass, valve *A* is closed, *B* is cracked and *C* is opened. This blows out any sediment which has entered the water column or glass and settled into the sediment tank. Valve *B* is then closed and *A* is cracked. This slight circulation will have little effect on the glass temperature, as the principal pressure drop occurs in the tank. After blowdown, the valves are left in normal position as previously described.

When installing a sediment tank, it must be remembered that this tank operates under boiler pressure. A short length of 3-in. extra-heavy pipe is easily adapted for this purpose and such a construction is shown in the figure.

Cleveland, O. M. E. WAGNER



Lubricator Made From Pipe Fittings

WHILE I was operating a plant in an isolated locality, the body of a lubricator burst. Several weeks' time would be required to obtain a new one, so it was decided to try and make a new body and mount the old fittings on it. As shown above, on left, the new body for the lubricator was made from a piece of 3-in. pipe, 6 in. long, with a cap on each end. These were drilled and tapped and the fittings of the old lubricator mounted. This makeshift operated satisfactorily for over a year until it was replaced.

Nelsonville, O. R. ROHE

CURRENT COMMENT

Vapor Process for Degreasing Leather Belts

IN THE JANUARY number of *Power,* I read the answers to the question on degreasing leather belts. Some of the suggestions offered brought to mind a principle I have seen applied. During an inspection trip through an industrial plant to investigate a vapor degreaser, I saw it used to remove grease and oil from leather belts. The system is intended for removing grease and oil from metal stampings and uses commercial trichlorethylene.

The solvent is heated by either steam coils or electric heating elements from which a vapor is generated at a temperature of 180 deg. F. The material to be cleaned is immersed in the vapor for one or two minutes, long enough to reach the temperature of the vapor. During the heating-up period the vapor is condensed on the surface of the material, drained off and carries with it the oil and grease. Cleaned pieces are then removed from the vapor clean and dry.

The vapor tank is operated with an open top. Water-cooling coils are operated near the top of the tank when it is desired to limit the upper surface of the vapor cloud. The belting is rolled into loose coils for conditioning, as the vapor is able to penetrate between surfaces that are near together.

Toledo, Ohio CHAS. F. HOFFMAN

Cleaning Oil-Soaked Floors

I AM interested in the discussion on "Cleaning Oil-Soaked Floors," including the article by Mr. Wheeler in the January number of *Power.*

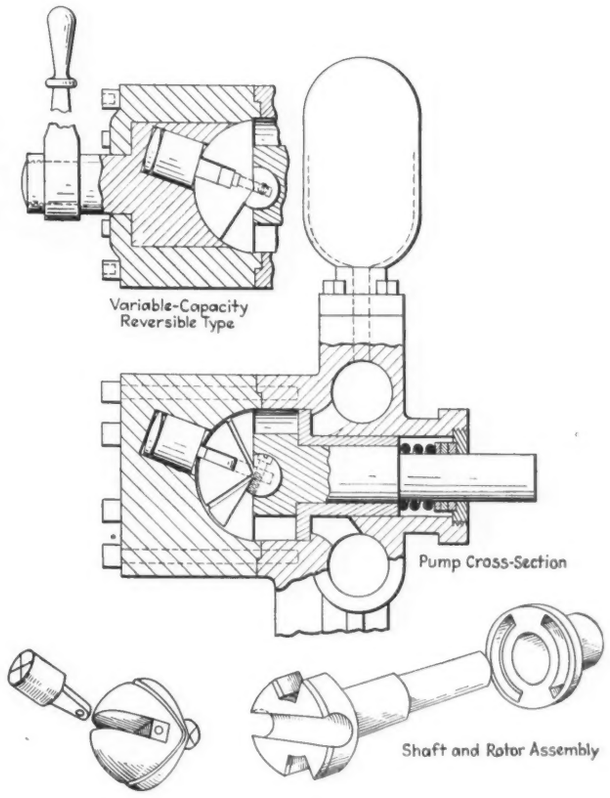
One point that seems to be overlooked in this discussion is the importance of taking the necessary precautions in repairing old floors and in installing new floors so that the work will be of such quality as to resist oil and other liquids. The labor required for repairing old floors or installing new floors costs no more for a floor that will be resistant to oil than for a porous floor which soaks up oil and disintegrates rapidly.

There are preparations on the market which can be incorporated in the cement topping at a cost of less than 1½ cents per sq. ft. for a 1-in. topping. These integral floor hardeners produce a good bond between the new topping or patch and the underlying concrete. They harden and waterproof the cement topping in one operation, produce high early strength so that the repair work or new work may be installed over the week-end and the floors used Monday morning.

New York, N. Y. M. W. MEYER

Further Types of Rotary Pump

SEVERAL new adaptations of the rotary pump described on page 512 of the October, 1933, number of *Power* have since been designed and built. The unit shown in Fig. 1 is an improved design of the original pump. In the new design, the spherical surface may be machined much more accurately and all parts can be taken out for inspection or repair without disturbing piping. Further, the pump can be repaired by simply replacing the head and rotor, while with the former design it was necessary to replace the entire body casting.



Variable capacity and reversibility may be added easily, as shown in the sketch at upper left, simply by changing the head and rotor assembly. An entire line of pumps with a wide range of capacities may be produced simply by using heads with pins at slightly different angles, with all main parts the same size. For example, with a 2-in. sphere, capacities can be as high as 10 g.p.m. Thrusts are also better neutralized.

Montclair, N. J. JAMES L. KEMPTHORNE

How Two-Type Current-Meter Method of Measuring Water Is Used

THERE seems to be a misunderstanding of the principle involved in the two-type current meter method as stated in the article "Meters and Control," in the January number of *Power.* We do not question the two-type current-meter method but the principle of applying it as laid down in the article mentioned above. The article states that the solution to the problem was found by a system of two types of current meters having opposite characteristics in running water, one type being retarded by oblique flow and the other accelerated by approximately an equal amount. This is not exactly correct because the satisfactory solution which we have obtained is based upon the use of two types of current meters, both under-registering.

Based on our research and as stated in the paper pre-

sented at the A.S.M.E. annual meeting last December, in New York City, we found that there are no current meters that over-register irrespective of the plane of approach, and which would have a stable and well-defined relation between the amount of registration and the angle of inclination to the flow. Since the A.S.M.E. test code at present specifies two types of meters having opposite characteristics, we were compelled to take exception to the code in this matter by using two types of meters which both under-register, but by various amounts. It is by means of this method that we found close agreement with another method commonly used, and it is this solution which we propose to adopt in the future.

Baltimore, Md. J. M. MOUSSON
Safe Harbor Water-Power Corp.

One Old Timer Writes About Another

ALTHOUGH early designs of synchronous motors are by no means comparable with their modern brethern, some of them still continue in service. At the Anderson Cotton Mills in South Carolina there is in operation an inductor-type synchronous motor that was built in 1895 by the Stanley Electric & Mfg. Co., a name probably foreign to many younger engineers. The motor, which is rated 300 hp., was first operated on 1,200-volt, 66⅔-cycle power, but was later reconnected for 600 volts and 60 cycles. The machine is soon to be discarded and junked. In this type of machine, both the field coil and the armature windings are stationary. There is only one field coil, and this is held so that the field core (which is supported on the shaft) revolves inside the coil.

The motor is started without load by a 15-hp. wound-rotor motor of the same age as the large motor. After the synchronous motor is synchronized with the power source, it is connected to the mill shafting by a clutch. This motor has operated almost continuously since its installation, and I have been associated with its operation for 33 years.

Anderson, S. C. W. J. LIGON

Still More About Blowdown

T. P. BROWNE's article "More About Blowdown," in the January *Power,* has been read with interest. It is my belief that an attempt is being made to extol the treating of water outside the boiler, asserting that the boiler should be used as a steam generator and not as a chemical retort, the inference being that by treating the water "outside of the boiler" no chemicals will be carried in.

To quote Mr. Browne, "Many engineers still retain the idea that blowdown is used for the purpose of removing suspended solids from the boiler, whereas the sludge, scale and suspension-forming material should never enter the boiler." And in the fifth paragraph, "The primary purpose of a boiler is to produce dry steam and not to serve as a chemical treating, reaction and settling tank." "If the scale and sludge-forming solids are removed, as they should be in a treatment plant before the water enters the boiler, little or no sludge forms in the boiler."

These statements are correct, but these results can be obtained only by using pure condensate for make-up. To illustrate, suppose we use a specific water so that the effluent from a zeolite water softener contains only 1 grain of sludge-forming material and 10 grains of potential solubles. This is a ratio of 1/10 and this ratio will be maintained in the boiler. If the concentration is permitted to build up 30 times, then in the boiler, there will be 30 grains per gallon of suspended matter and 300 grains per gallon of solubles. To maintain this concentration, the blowdown must remove the suspended matter as rapidly as it is fed to the boiler, and this is, of course, true with the soluble matter also. The point is, both suspended matter and soluble matter do exist in the boiler, contrary to the inference in Mr. Browne's article.

The most efficient and adequate way devised to remove suspended solids from the boiler is to provide for outside sedimentation for the maintenance of a pre-determined low concentration of suspended matter in the boiler. This is true regardless of what type of treatment or what treating system is used.

The statement that the water should be treated outside of the boiler in order to prevent potential suspended matter from getting into the boiler is excellent, but these results are not obtained when treating the water by means of a lime-soda softener, a zeolite softener or any other means of outside treating except evaporation.

With a properly designed sedimentation vessel outside the boiler, and circulation of the correct amount of boiler water through this sedimentation vessel, it is possible to maintain in the boiler a concentration of suspended matter not greatly in excess of the amount of suspended matter in the make-up.

The maintenance of this low concentration of suspended matter permits a relatively high concentration of soluble matter to be maintained without the danger of the delivery of wet steam or foaming. This permits a minimum of blowdown, much less than if the blowdown were used for the removal of suspended matter.

Elgin, Ill. E. F. ECKEL
Elgin Softener Corp.

Water Seal Traps Air

IN THE December number of *Power,* page 647, M. E. Wagner brings home the need of individual condensate drains, but he has not reckoned with the elimination of air or the attendant retarded condensate discharge in his suggested use of a loop water seal.

Assume the 80-lb. existing trap line in the sketch is in operation, and the heater coil is turned on only as the oil needs to be heated. When starting to heat the oil the steam pressure drives the air toward the water seal. Before the air is all driven from the coil, condensation takes place and condensate gravitates into the descending leg of the loop before all the air is forced from the coil.

As this condensation gravitates into the descending leg of the loop, it finds a pipe full of air and water. As the water in the loop will be at a point of unbalanced pressure, some of the condensate will pass the air in gulps and force some of it out through the loop. The rest of the air will have to wait for a column of condensate to form behind it sufficiently high to force it into the existing trap line. This cycle will be repeated as often as air gets into the coil or until a non-return atmospheric vent is installed.

Brooklyn, N. Y. WM. ANDERSON

TECHNICAL CO-ORDINATION NEEDED IN

SMOKE ABATEMENT

1—TIME FOR ABATEMENT

IN MOST large cities, the ethics of the people do not yet forbid a contaminated atmosphere. Smoke is tolerated although it is constantly condemned in the abstract. Elliott H. Whitlock, consulting engineer, Cleveland, O., at a recent meeting of the Providence section of the A.S.M.E., asserted that this condition is a challenge to the engineer, and he advocated better co-ordination of methods and of smoke-prevention regulations as a way out. He said in part:

The solution of the problem requires a careful analysis of combustion requirements, the limitations within which the fuel is to be burned and the resultant products of combustion.

In the burning of ordinary fuels, the products of combustion discharged from the chimney are: carbon dioxide (CO_2), carbon monoxide (CO), carbon particles, sulphur gases, ash, water vapor and a small percentage of one or two other gases too small to consider. Since CO_2 is a part of the normal atmosphere, it cannot rightfully be classed as an impurity. Similarly, water vapor also may be disregarded. This leaves four substances to contend with as impurities:

First: Carbon monoxide (CO). The presence of this gas indicates clearly some faulty condition during the process of combustion, since with sufficient air supply and proper temperature this gas combines freely with another atom of oxygen to form CO_2, with the release of an appreciable amount of heat. This heat would have been released in the combustion chamber had the design been correct and proper conditions maintained; therefore, the money loss is in most cases chargeable to the engineer for poor design and/or faulty construction. This gas, which is an impurity in the atmosphere, need not and should not escape from a chimney.

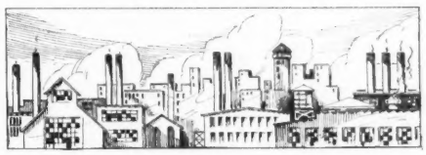
Second: Carbon particles. Comments similar to the above apply to carbon particles. The responsibility again comes back to the engineer and to the design and construction.

Third: Sulphur gases. This impurity presents quite a different problem, since there is no known chemical reaction that can be effected within the combustion chamber to rid the gas stream of the sulphur; it is necessary to treat the waste gases for its removal. So far, no commercially efficient method has been devised, although progress is being made, so here again the engineer has an opportunity.

Fourth: Ash. The percentage of the original ash in the fuel that may be discharged from the stack varies considerably, partly because of imperfect combustion, but more particularly because of wide differences in amount of the draft used in different cases and also in the variable amount of agitation of the fuel bed. Notable advances have been made in the last few years toward bringing under control the amount of solids discharged from a chimney. The installation of equipment for this purpose is still quite expensive, which tends to limit its use to the larger fuel-burning plant. The challenge to the engineer is to adapt these known principles or improved methods for practical application to smaller chimneys.

If it be granted that clean air can be obtained, will it be possible to maintain such conditions?

There are several cities on record where excellent results in smoke abatement have been obtained, but where, therefore, due to false economy or some other reason, efforts for control have been curtailed or abandoned. The almost immediate effect is a return to the former smoky condition.



2—ABATEMENT IN FORCE

The U. S. Bureau of Mines has definite records of such a case in Salt Lake City. And here is what an interested party wrote about the recent fiasco in Cleveland: "Every thing has run wild and the work of six years has been largely undone in six months. **** Buildings that have not been violators for years are as bad as ever. Even places with underfeed stokers are violating because of lack of supervision." Other cases might be cited, but these two indicate very clearly that constant and continuing supervision must be provided in order to maintain any beneficial results.

Dr. O. P. Hood of the Bureau of Mines has often and forcefully stated that the lack of a continuing policy has been one of the most serious drawbacks to the progress of smoke abatement work.

In Cleveland, there were eight different men in charge of smoke abatement work in fifteen consecutive years and the longest term of any one was four years!

Another illustration of the chaotic condition of smoke abatement work is that it has not yet become recognized as a function of any particular department of Government. For example, in 58 cities in this country, smoke abatement work is assigned to the following departments: Health (16), Building (13), Fire (7), Boiler (6), Engineer (5), Sanitary (5), Safety (4) and Police (2).

A digest of the ordinances from 125 cities shows that practically no two are alike, though some are similar. In many there is no definition of "smoke"; in others the definitions are dissimilar. This indicates that the engineer has had little if anything to do with originating smoke abatement work in these cities.

One of the latest novelties in Smoke Ordinances requires that the head of the department and his assistant shall both be engineers with the qualifications for membership in the A.S.M.E. Also an advisory board is specified whose members must have the same qualifications. All engineering rules and regulations must be instigated and promulgated by the department head and this board.

Under this scheme, the ordinance is not bulky and satisfies the legal requirements, setting up the definitions, authority, and penalties, and deputizes the engineering fraternity to tend to its part of the business.

This set-up has been in operation for the past three years and no serious objections have been encountered. The abatement of smoke has been very evident. Naturally, engineers did have something to do with the framing of these particular ordinances!

It is absolutely necessary to maintain control by proper authority if favorable conditions are to continue. Until recently, the work of smoke abatement has not been recognized as an engineering problem.

Continuous Pressure Essential

If and when a realization of this fact can be brought to the consciousness of those in control of our political subdivisions, there may be more hope of obtaining a continuing policy where smoke abatement is attempted. The reasoning that leads to this conclusion is drawn from the analogy of this type of engineering work to the somewhat similar types of engineering that have long been functions of our political units, such as water supply, streets and lighting. In such departments, history is replete with instances where the technical head has remained in charge over long periods and through various changes in political control.

Our citizens are educated to the necessity of pure water to prevent the spread of disease, also of the necessity for pure food to prevent sickness. Both of these efforts are under the control of our local governments, but the technical details are left to competent technically trained staffs. Hence it would seem logical to argue that if our citizens want pure air they should be made to realize that this is another function that requires the constant supervision of a technically trained staff, and for this particular work they should be mechanical engineers.

3—POLITICS COMES IN

THE A-B-C OF ALGEBRA

By C. R. CHADBOURNE

IT IS often convenient to use letters to represent numbers. Thus, if I wished to give a rule for finding the number of square feet in an iron plate, I should say "multiply the length by the width of the plate." I can write it in this way.

Length time *width* equals *area.*

Now, it is not necessary to write the words *length, width* and *area.* Just take the first letter of each word and let that stand for the word. Then we have $L \times W$ equals A, or LW equals A, since in algebra the sign of multiplication need not be written. That is all an algebraic expression is—simply letters standing for the names of certain quantities.

Algebra is Simplified Arithmetic

Algebra, then, is only a simplified arithmetic, but it is something the engineer and electrician cannot get along without, because he cannot go far in his calculations unless he learns to take short cuts, and algebra furnishes the short cuts. We shall give a few more illustrations to show what an algebraic expression is.

Suppose a hardware merchant is invoicing. He finds that he has in a certain stockroom 100 lb. of bolts, 200 lb. of nails and 150 lb. of spikes. He goes through his entire stock in this way, writing down the name of each kind of article. Now, he could save much time if he would let b stand for bolts and write $100b$; n stand for nails and write $200n$; s stand for spikes and write $150s$. Then this part of his stock would be $100b$, $200n$ and $150s$.

He might choose other letters to stand for these articles. It does not matter what letters are used, provided one letter always stands for the same thing. He could not keep his accounts straight if he let b stand for bolts in one stock and spikes in another.

When he takes his invoice in this way he is using algebra. If he writes the stock in the first room $100b$ plus $200n$ plus $150s$ he has written an algebraic expression.

Circumference of Circle

By the use of algebra we can express any rule more briefly than we can with words and numbers. Take, for example, the rule for finding the circumference of a circle. To find the circumference, multiply the diameter by 3.1416. So we have:

Circumference equals 3.1416 times *diameter;* or, since the diameter equals twice the radius:

Circumference equals 2 times 3.1416 times radius

c equals 2 times 3.1416 times r

The number 3.1416 is represented by the Greek letter π (pronounced "pie"). So we have:

$$c \text{ equals } 2\ \pi\ r$$

Area of Circle

We may also write a simple equation for the area of a circle. Area equals the radius multipled by itself, and this result multiplied by 3.1416.

Area equals 3.1416 times *radius* times *radius*:

By algebra, a equals $\pi\ r^2$.

Volume of Box

To find the volume of a square-cornered box or tank, we may let l, w, and h stand for length, width and height. Let v stand for volume or contents.

Then v equals lwh

The above examples have been given to show why algebra is used. Many more might be given to show that algebra, when rightly used, makes things much simpler. In each of the examples given we have an equation, one quantity equal to another quantity.

EXAMPLES

1. Using the last equation, find the volume if l equals 12 ft., w equals 6 ft., h equals 4 ft.

Answer—288 cu.ft.

2. From the same equation find what the height must be if l equals 7 ft., w equals 6 ft. and v equals 168.

Answer—h equals 4 ft.

3. In the equation "a equals $\pi\ r^2$," if r equals 2 ft., what does a equal?

Answer—a equals 12.5664 sq.ft.

Volume of Tank

We have learned that we can find the volume of a circular tank by multiplying the area of the base by the height. Now, as we have just seen, the equation for the area is:

a equals $\pi\ r^2$.

Therefore, if v is the volume and h the height, v equals a times h, or ah, which equals $\pi\ r^2 h$.

Since a equals $\pi\ r^2$, multiplying a by h is the same as multiplying $\pi\ r^2$ by h.

So we say ah equals $\pi\ r^2 h$.

Hence v equals ah equals $\pi\ r^2\ h$.

EXAMPLES

4. Using the above equation, find the capacity of a circular tank if r equals 3 ft. and h equals 5 ft.

Answer—141.372 cu.ft.

5. If a circular tank is to hold 300 cubic feet, and its radius is 4 feet, what must be its height? Use the same equation as in Example 4 and find what number you must multiply $\pi\ r^2$ by to give 300.

Answer—Nearly 6 ft.

Adding and Subtracting Algebraic Quantities

Addition and subtraction in algebra are like addition and subtraction in arithmetic.

If a man goes into business with a capital of $10,000, and owes $4,000, his net resources are $6,000. We may call the capital plus 10,000 and the debt minus 4,000. When we add the debt to the capital we get the net resources. The minus sign is used to represent the liability side of the account.

A good example of negative numbers is a below-zero temperature. Suppose, on a winter day, the thermometer reads 10 deg. below zero. The temperature is minus 10, also written —10. This is a minus quantity or a negative quantity. Now, we can add two negative quantities just as well as we can add two positive quantities. If we add —10 and —5, the result is —15.

It Works with Thermometers

If the highest temperature were plus 10 deg. and the lowest temperature minus 10 deg., then the average of these two temperatures would be zero; that is, the point half way between the lowest and the highest temperatures would be zero. This illustrates the fact that when we add a plus quantity to an equal minus quantity the sum is zero.

We can subtract a negative quantity from a positive quantity. Suppose that on a certain day the thermometer reads 10 deg. above zero, and at night it reads 5 deg. below zero. What is the difference between the two temperatures? We must subtract —5 from +10. Now, we can see that the mercury has fallen 15 deg. We know then that —5 subtracted from +10 equals +15, or, to state it another way, we know the difference between +10 and —5 is 15. Now, +5 added to +10 gives 15. We see, then, that to subtract —5 is the same as to add +5.

EXAMPLES

1. Add —10 and —4..... *Answer*, —14
2. Add —12 and —4..... *Answer*, —16
3. Subtract —6 from +10... *Answer*, +16
4. If the highest temperature on a certain day is +20 deg., and the lowest temperature is —10 deg., what is the difference between the two temperatures?..... *Answer*, 30 deg.
5. Add $+2a$, $-3a$, $+4a$..... *Answer*, $+3a$
6. Add $3a$, $6b$, $7a$, $10b$

   Answer, Only quantities of the same kind can be added, so we have $10a + 16b$.
7. Collect and add the terms of the same kind in the following expression: $6a + 2b + 7c + a + 3b + 5c - 4c$. *Answer*, $7a + 5b + 8c$.

Multiplying and Dividing

If a merchant has 100 lb. of bolts, which he represents by $100b$, and doubles his stock, he will then have $200b$. If he divides his original stock into two equal parts he will have in each part $50b$. This illustrates multiplication and division when the signs are all +.

Suppose a man owes $5,000, which we shall represent by —5,000, and to enlarge his business makes his indebtedness three times as great as at first. Then his indebtedness is represented by —15,000. If he reduces his indebtedness, making it one-fifth what it was at first, we have to divide —5,000 by 5 and we get —1,000. This illustrates division when the dividend is a minus quantity.

In both these illustrations the divisor and the multiplier are plus quantities, and this is true in all the practical problems which the engineer and electrician will meet.

In many problems it is necessary to multiply a symbol by a symbol. We had an illustration of this when we multiplied the radius of a circle by itself in finding the area. Now, r is a symbol for the radius of a circle. It stands for the radius of any circle. It may be 1 in. or 10 ft., or any other number. So we cannot give r any definite value until we are working some particular circle. But we can say r multiplied by r, meaning the radius of any circle multiplied by itself. We write it r^2. If we were to multiply 3 r's together, we should write it r^3. The small figure above the r tells how many r's are multiplied together. This number is called the exponent.

If we have a cubical tank, length, width and height equal, and we wish to find the capacity of the tank, we multiply length, width and height together. Since these three are equal, we are multiplying the same number by itself 3 times. Let l stand for the length of each edge of the tank. Then the capacity is l^3. If we know the capacity and the length of one edge, we can find the area of the bottom by dividing l^3 by l. This gives l^2. Thus, dividing by l makes the exponent one less. Multiplying by l makes the exponent one greater.

Division of one algebraic quantity by another may be expressed in the form of a fraction. Thus $\frac{a}{b}$ means a divided by b, just as $\frac{2}{3}$ means 2 divided by 3. For example, if a represents the area of a rectangular figure, and b represents one side, then $\frac{a}{b}$ equals the other side. This statement is strictly true for every rectangular figure, but we cannot actually divide a by b until we apply it to some particular figure and so have a definite number for the values of a and b. Thus, if a equals 10, and b equals 2, the other side of the rectangle equals $\frac{10}{2}$ equals 5.

Fractions in algebra are dealt with in exactly the same way as fractions in arithmetic. A fraction is multiplied by multiplying its numerator. Thus, 2 times the fraction $\frac{a}{b}$ equals $\frac{2a}{b}$

A fraction is divided by dividing its numerator or by multiplying its denominator. For example, the fraction $\frac{a}{b}$ divided by 2 equals $\frac{a}{2b}$; the fraction $\frac{6a}{b}$ divided by 2 equals $\frac{3a}{b}$; the fraction $\frac{a^2}{c}$ divided by a equals $\frac{a}{c}$.

A fraction is not changed by multiplying both numerator and denominator by the same number. For example, $\frac{a}{b}$ is equal to $\frac{2a}{2b}$, just as $\frac{2}{3}$ is equal to 4/6. Multiplying both terms of the fraction by 2 does not change the value of the fraction.

A fraction is not changed by multiplying both numerator and denominator by the same number. Thus, 8/10 has the same value as $\frac{4}{5}$; so $\frac{3a}{6b}$ has the same value as $\frac{a}{2b}$.

It must not be supposed, however, that we can add the same number to both terms of a fraction without changing its value. For example, add 2 to both terms of the fraction $\frac{1}{3}$ and we have $\frac{3}{5}$, but $\frac{1}{3}$ is not equal to $\frac{3}{5}$. Neither can we subtract a number from both terms of a fraction. We cannot do this either in arithmetic or algebra.

EXAMPLES

1. Multiply $50a$ by 3.... *Answer*, $150a$
2. Multiply $-100b$ by 4. *Answer*, $-400b$
3. Divide $50a$ by 5..... *Answer*, $10a$
4. Divide $-100b$ by 4... *Answer*, $-25b$
5. Multiply c^2 by c..... *Answer*, c^3
6. Divide t^3 by t..... *Answer*, t^2
7. Divide a by c..... *Answer*, $\frac{a}{c}$
8. Multiply $\frac{c}{d}$ by 2..... *Answer*, $\frac{2c}{d}$
9. Divide $\frac{c}{d}$ by 2..... *Answer*, $\frac{c}{2d}$
10. Multiply $\frac{c}{d}$ by c..... *Answer*, $\frac{c^2}{d}$
11. Divide $\frac{c^3}{d}$ by c..... *Answer*, $\frac{c^2}{d}$

As a special service to readers who have come into the operating field without a background of technical education, "Power" has presented occasional articles by Mr. Chadbourne dealing with the application of elementary mathematics to power problems. These are in a form easily followed by any man with a common-school education. The previous article, which appeared in Sept., 1932, showed how to figure the capacities of tanks and boilers

Compressed-Air Operation Of Steam Hammers

WHETHER a steam hammer is looked upon as power equipment, or production equipment (and it is both) power engineers in steam-hammer equipped shops will be interested in N.E.L.A. Publication[1] No. 238, August, 1932. Under the title "Compressed-Air Operation of Steam Hammers," this discusses the advantages and disadvantages—chiefly advantages—of changing over steam hammers to air operation.

Boiled down, the arguments presented for the use of air may be summarized as follows:

1. Standby losses, due to condensation in pipes and hammers, are eliminated.
2. It is unnecessary to idle an air hammer between jobs, to avoid condensation in the cylinders.
3. Using air, the hammer starts immediately, without warming out. The action is quicker, and blows sharper.
4. There is a marked reduction in the lubricating oil necessary.
5. Simplified lubrication is reflected in lower maintenance and repair charges. In case of breakdown the hammer is cold, and repair work can be started at once.
6. The use of air eliminates the fire cracking and breakage of dies by dripping of condensate. Moreover, certain classes of work must be kept free from drip.
7. Packing and stuffing gives two to five times the life.
8. Since air compressors can usually be placed close to the hammers, shorter pipe lines and simplified layout may be used.
9. Plant power factor may be improved, and over-all unit cost of power reduced.

[1]Price 30 cents to non-members. Edison Electric Institute (formerly N.E.L.A.), 420 Lexington Ave., New York City.

BETTER AIR

IS A.S.H.V.E.'S PRINCIPAL TOPIC

Air-conditioning tips for building and plant engineers—effects of windows, shades and climatic drive—corrosion in heating plants—new equipment at the Heating and Ventilating Exposition

AIR-CONDITIONING Pointers applicable to industrial plants and large office buildings were included in papers on conditioning residences presented at the fortieth annual meeting of the American Society of Heating and Ventilating Engineers at the Hotel Biltmore, New York, N. Y., Feb. 5-8. Eight of seventeen papers were of interest to engineers dealing with larger installations. Concurrently, the Third International Heating and Ventilating Exposition was held at Grand Central Palace, under auspices of the Society.

After the Society meeting Feb. 9, manufacturers of heating, ventilating and air conditioning equipment discussed NRA codes. Beverley S. King, deputy administrator, said that several manufacturers had suggested a blanket code for these manufacturers, to avoid present operation under several codes. A committee was appointed to determine the desirability of such a code, and if desirable to make a preliminary draft.

The Society elected C. V. Haynes as president for 1934, John Howatt first vice-president, and G. L. Larson second vice-president. D. S. Boyden was continued as treasurer and A. V. Hutchinson as secretary.

Sun's Radiation Increases Air-Conditioning Load

What is the heating effect of sun radiation on spaces to be air-conditioned? Two papers dealt with this question, "Radiation of Energy Through Glass," by J. L. Blackshaw and F. C. Houghton, and "Studies of Solar Radiation Through Bare and Shaded Windows," by F. C. Houghton, Carl Gutberlet and J. L. Blackshaw. Both gave test results from the Society's Pittsburgh laboratory. The first showed that ordinary double-strength window glass transmits no measurable amount of energy radiated from a source lower than 500 deg. F. in temperature. Thus, furniture and fittings at room temperature will not transmit, by radiation, any heat through a window to colder outside temperature. The same glass transmits 76.3 per cent of the radiation from an incandescent tungsten lamp and 88.9 per cent of the radiation from the sun. Thus, it would seem that glass windows constitute heat traps which allow rather free transmission of radiant energy into the room from the sun to warm the objects in it, but not allowing the transmission of re-radiated heat from these same objects.

Discussion brought out that window glass is heated by the radiation which it absorbs, that heat is transmitted through it by convection, and it, therefore, does not act as a heat trap. Other discussions called attention to the availability of special glasses which limit the amount of infra-red rays transmitted.

The second paper dealt with work to determine the effect of various types of shades and blinds on cutting down the amount of solar radiation through windows. The important effect of sun's radiation on air-conditioning load is illustrated by simultaneous tests on two identical rooms. With the cooling equipment in these rooms shut down, the temperature of the room having a bare window rose to over 90 deg. with an outside temperature of 86 deg., whereas in the room with the window completely shaded the temperature rose only to slightly above 82 deg. Approximately 80 per cent of the heat that the cooling unit is required to remove is due to solar radiation through windows.

A standard buff window shade inside the window was found to transmit 45 per cent of the sun's radiation, whereas when placed outside of the window the shade transmitted only 27 per cent. A standard awning transmitted 26 per cent; a Venetian blind, coated with aluminum and outside the window, transmitted as low as 12 per cent. Complete shading was accomplished by placing four large canvas shields in front of the window, the nearest being 7 in. from the glass, the other three successively with three 4-in. air spaces. With this arrangement, only 5 per cent of the sun's radiation was transmitted through the window.

The paper by W. J. McConnell and I. B. Kagey, "Study of Air Conditioning and Office Employees' Efficiency," was in two parts. The first, presented by Dr. McConnell, dealt with the effect of the system on office employees and gave some operating data. The second part, presented by Mr. Kagey, described the air-conditioning installation of the Metropolitan Life Building. Mr. McConnell said that the indoor temperature maintained at this building was not held constant, but varied with outdoor temperature during the summer. A maximum indoor temperature of 78 deg. was maintained, with outside temperatures of 90 deg. or above. Relative humidity was held between 43 and 53 per cent. With these conditions, occupants felt no chilliness upon entering the building, and experienced less fatigue during the day. However, when leaving the building at night, the heat outside was found to be quite intense. While no records of absenteeism have been kept, nevertheless it was felt that considerably better efficiency had been obtained from the staff.

Normally, the air-conditioning system operated 11 hours a day, except during very hot weather, when the system was started two hours before occupancy instead of one hour. During the past year, the refrigerating equipment operated 1,230 hours and developed a total refrigeration of 29,000 tons.

A New Weather Angle

Discussers brought out on several occasions that the medical profession was not yet able to say definitely just what air conditions were best. A paper by B. A. Mills threw some light on this subject. The paper contained a map showing areas of "climatic drive," and the effects which the climate had on the inhabitants of these regions. Regions of high climatic drive give to the inhabitants an abundance of energy. Unfortunately, the body is not capable of unlimited response to climatic stimulation. Definite signs of breakdown under the strain are visible. The Doctor showed that certain bodily troubles, such as diabetes, pernicious anemia and cancer are more prevalent in areas of high climatic drive. Wide swings in temperature and barometric pressure, due to storms, were also found to have a marked effect on health. Acute appendicitis and suicides, for instance, have been found to come mainly with periods of rising temperature and falling pressure that preceed storms.

In areas of low climatic drive, the energy level of the inhabitants is much lower, and they suffer less from diseases of exhaustion. At the lower energy level, however, they are more susceptible to infection, such as tuberculosis and acute appendicitis. The paper suggest that air-conditioning should be controlled to smooth out or lessen climatic drive in high-drive areas and to raise the drive in low areas.

Another paper, by T. S. Kendall and Garland Weidner, dealt with the effects of air-conditioning on hay-fever sufferers. During the 1932-1933 season, Dicker Hall, University of Kentucky, was made available as a haven for sufferers from hay fever. It was found that those whose hay-fever symptoms were sneezing and irritation of the mucous membrane receive greatest relief upon visiting this air-conditioned

hall. Those suffering with irritated eyes and face and running nose obtained moderate relief, while stopped-up nose, headache and depression were relieved but slightly.

Heating Plant Corrosion

Corrosion in heating plants of many localities is of extreme importance. Attempts have been made to determine the relationship of oxygen, carbon-dioxide, pH value and method of operation on the corrosive properties of condensate in steam-heating systems, but it has been impossible to control these various factors individually. A laboratory set-up at the Michigan College of Mining and Technology has been devised in which these variable factors can be controlled and their effects determined. This laboratory was described in a paper by R. R. Seeber, F. A. Rohrman and G E. Smedberg. Criticisms and suggestions were requested, in order that the work (which is in co-operation with the A.S.H.V.E. Research Laboratory), might yield most beneficial results.

Determining the required size of heating plant involves equating two quantities, namely, heat loss from the building and heat to be supplied by the heating apparatus. There are many factors which have a bearing on loss of heat from a building. These may be broadly classified as (1) inside conditions, (2) outside conditions, and (3) the building. Outside weather condition include temperature, direction and velocity of wind, humidity, precipitation, and percentage of sunshine.

In making the calculation, certain temperatures are assumed. The inside temperature to be maintained at a given level in the room is specified. The outside temperature is assumed to be usually 10 or 15 deg. above the lowest temperature on record for the district in which the building is located. The wind velocity selected for making the infiltration calculations is usually the average during December, January and February. Wind velocity and temperature are applied together in arriving at infiltration losses, yet they may have no relationship to each other. The problem is to determine the worst combination of weather conditions, the two most important factors being temperature and wind velocity; it seems logical that the temperature and wind velocities selected should be those occurring at the same time, or the average during some interval.

Results of an analysis to test the accuracy of this assumption, were presented by Paul D. Close. Heat losses from various types of construction for various temperatures and wind velocities were compared with actual meteorological records of the City of New York. In the case of the room studied it was found that heat loss at 0 deg. and 0 m.p.h. wind would be the same as that when the outside temperature was 30 deg. and the wind velocity 10 m.p.h. In this particular case, the heat loss is doubled for the same outside temperature if the wind movement changes from 0 m.p.h. to 13.3 m.p.h. and is tripled for the same outside temperature if the wind movement changes from 0 to 26.7 m.p.h.

An analysis of weather conditions in New York City disclosed the wind velocity on very cold days was seldom over 22 m.p.h., and that during December, January and February, windy days (above 22 m.p.h.) are seldom cold. Application of this data to the construction studied showed that heat loss on many days of relatively high temperature and high wind is greater than the heat loss calculated under the temperature and wind velocity conditions normally assumed.

In discussion, it was suggested that the method of calculation suggested by Mr. Close should be used with caution until checks had been made with results obtained in actual buildings.

A paper by John A. Goff, "Thermodynamic Properties of Moist Air," contained a tabulation of the properties of atmospheric air based on the best available thermal data, together with the thermodynamics involved in its use and calculation.

A code for testing and rating return-line low-vacuum heating pumps was approved with minor changes and is now ready for formal adoption by mail ballot.

Heating and Ventilating Exposition

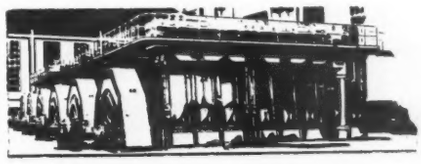
Most of the exhibits at the Third International Heating and Ventilating Exposition were for residential heating or air-conditioning systems. New equipment of interest to power engineers included a recording regulator by Taylor Instrument Companies. One feature of this instrument is a sensitivity adjuster which makes it possible to change pen-arm movement to cause a full one-way stroke of the diaphragm control valve and so adapt the regulator to the apparatus controlled. The adjustment provides infinite sensitivity values of from 0.005 to 4½ in. pen movement for a full stroke of the diaphragm valve. Other features include precision mechanism for changing control point, duralumin levers with special frictionless bearings, compensator for fluctuating air pressure and micrometer pen-arm adjustment.

Two new forms of aluminum heat insulation were shown by Reynolds Metal Company. One for insulating low-pressure steam piping consisted of cellular asbestos pipe covering coated inside and out with aluminum foil. Spacers of cellular asbestos covering form an air space between pipe and insulation. For insulating flat surfaces, aluminum foil is cemented to a heavy, tough kraft paper. Panels built up of several layers of aluminum-coated paper with air space are also available.

Sarco Co. exhibited a new boiler return trap for use with vapor heating systems. When the trap receiver fills to a given level, a float trips a weight which closes the air vent and opens the steam valve, applying boiler pressure to the receiver. The trap is installed above the boiler. Inlet and outlet are through the same opening in the bottom.

Improved boiler water-level controls and low-water cut-off switch for oil- or gas-fired boilers were exhibited by McDonnell & Miller. The water-level controller is constructed so that no linkages are exposed to water, and sylphon bellows replace stuffing boxes.

An iris shutter valve developed by York Oil Burner Co. is available in sizes from 1 to 72 in. diam. The valve is particularly suitable for use with automatic regulators where close control of air and gas is required.



FOREIGN POWER

Krasnoe Sormovo Works, in Soviet Russia, has turned out its first 2-stroke, 4-cyl., 700-hp. diesel. It is destined for a motor vessel on the Gorki-Astrakhan line. Another diesel of 1,200 hp. is now under construction.

The first turbine at Svirstroi power station near Leningrad, U.S.S.R., generated 1,000,000 kw. of energy for Leningrad between Dec. 13 and 24. The generator worked at a load of 22,000 kw. Assembling of the second turbine has been completed.

Three local electric stations are being constructed in White Russia. These stations are to serve local enterprises and will use waste from the saw mills and peat for basic fuel.

Three 72,000-kva., 3,000-r.p.m. turbo-generators are being constructed by Forges et Ateliers de Constructions Electriques de Jeumont, France, and Ateliers de Constructions Electriques de Charleroi, Belgium, for the new St. Denis power station of Société de l'Electricité de Paris. Electric welding is being used in fabrication.

Operating under highest head of all hydro-electric stations, the new 157,000-kw. plant on the Dixence River in Switzerland will have an operating head of 5,740 ft. A special tunnel, 7 miles long and about 8 ft. in diameter, will connect the storage reservoir with the penstock. The latter will lead water to the turbines and five generators having an output of 37,500 kva. each, at 13,000 volts and 500 r.p.m. Three units will be installed at present. An auxiliary generator, with an output of 7,500 kva. at 10,000 volts, will supply electric energy to the control station and to a few adjacent villages. The station will be used only six months each year, principally in winter, the balance of the time being required to store water.

The Government of Mexico, Mexico, D. F., is considering a measure providing for state construction and operation of electric light and power plants, and proposition will be submitted to the Legislature at the next session. The proposed law provides that prices for electric service to the consumers shall be equal to or less than the local price of charcoal and wood fuel.

Twelve ovens, an exhauster, condensers, and an extension of the naphthalene washer have just been completed in the new gas plant of the B. C. Electric Railway Co., Vancouver, B. C. The plant erected one year ago had a capacity of 3,000,000 cu.ft. daily. The new addition will step up gas production to 4,500,000, and coke production to 50,000 tons annually.

READERS' PROBLEMS

The "Still" Engine

"STILL" ENGINE AND HEAD TEMPERATURES.—*On page 630 of "O'Rourke's General Engineering Handbook" is a short description of the Still engine, an internal-combustion engine which produces steam in its water jacket to be used on the under side of the piston. I am interested in learning more of the actual construction and operation of this engine and thought it might be described in some earlier edition of* POWER. *If not, can you advise how I can get a more detailed description of this engine?*

I should also like to know the average maximum temperature of the inner surface of the combustion head of a water-cooled internal combustion engine at the end of combustion. None of the books that I have give his information, and I will appreciate any assistance that you may give me.

J. G. K.

The Still oil-steam engine has double-acting cylinders, one end forming the cylinder for the internal-combustion engine cycle and the other forming the cylinder for the steam cycle. Cooling water circulating around the internal-combustion portion of the cylinder jackets is used as feed water in a boiler heated by the internal-combustion engine exhaust gases. Steam generated is distributed to the steam part of the cylinder by means of a piston valve.

In starting, the boiler is fired in the ordinary way with oil, so that the steam cylinder can be operated. As soon as the engine has gathered sufficient speed, the oil engine is brought into use and the oil burners are cut off, but steam is always available, since it is generated from the heat recuperated from the exhaust gases of the oil engine.

Thermal efficiencies as high as 41 per cent have been obtained with this cycle and thermal brake efficiency from below ¼ load to full load averages about 40 per cent. Fuel consumption runs as low as 0.302 lb. per brake-horsepower.

Power described an engine of this type, installed in the motorship "Dolmus," on pages 730 and 731 of the Nov. 16, 1926, number. You can also find a complete description of the engine, with diagrams and design data, in the book "Oil and Gas Engine Power," by A. W. and Z. W. Daw. This is an English book, reprinted in America by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City, N. Y., some years ago.

As far as we are aware, the engine has been used only in this one marine installation and in several test land installations.

The average maximum temperature of the inner surface of the combustion head of a water-cooled internal-combustion engine runs about 600 to 700 deg. F., and the inside surface temperature is 50 to 80 deg. higher than the outside temperature. This is for a gasoline engine. In the same engine, an aluminum piston top would run 500 deg., and a cast-iron piston top 700 deg.

In diesel engines the usual mean temperatures are:

For the cylinder head.500 to 600 deg.
For the uncooled piston top .....700 to 800 deg.
For the water or oil-cooled piston top....400 deg.

The liner will be about 500 deg. near the combustion space, dropping to 150 to 200 deg. at the other end, an average of 340 deg.

Fluctuation during the cycle is relatively minor. In a two-cycle engine it runs 25 deg. above the average at combustion and 15 deg. below at the end of the exhaust, or a 40-deg. fluctuation. In a four-stroke engine, the fluctuation is 25 deg. each way, or a total fluctuation of 50 deg. This fluctuation is only at the inner surface of the combustion chamber and penetrates but very little. For example, ⅜ in. from the inner surface, the temperature variation through the cycle will run only about 1 deg.

Further information on this subject can be obtained from two recent books, both published by the McGraw-Hill Book Co. These are "Internal Combustion Engines" by Streeter and Lichty, and "Internal Combustion Engines" by Maleev. The latter book is somewhat more complete on this particular subject. The prices are $4.50 for the first and $4.00 for the second.

QUESTIONS for Our Readers

Corrosion in Condensate Return Line

QUESTION 1

I AM *experiencing considerable trouble from corrosion in the condensate return line from a water heater. The heater is supplied with steam from our heating boiler. Boiler feedwater receives a light treatment of soda ash. Corrosion is most severe in the piping just ahead of the heater condensate trap. What is the probable cause, and what can I do to stop it?*—O. N. R.

What Is Good Insulation?

QUESTION 2

WHAT *is good insulation on electrical power-plant equipment? That is the question that is troubling me. If the A.I.E.E. Standard minimum insulation resistance is accepted, then, for medium- and large-size machines, the resistance may be less than 0.5 megohm, a value that I feel many engineers will consider too low. If we do not accept the A.I.E.E. Standard, then what rule are we to use for a guide as a safe value of insulation resistance? How frequently should insulation resistance tests be made? When the insulation resistance of a machine is low, what is the best way to go about bringing it back to a good value? What is the lowest-voltage machine on which it is safe to use a 500-volt megohm meter? Probably* POWER *readers can tell me how they handle these and other problems having to do with maintaining the insulation in a safe condition on electrical machinery.*—I. R. H.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Do New Oil Burners Under Old Boilers Damage Boilers or Settings?

ANSWERS to January Question 1

THE QUESTION

I AM *contemplating changing from hand firing to oil fuel and have been told that new oil burners under old boilers sometimes result in damage to the boiler or boiler setting. I would appreciate the experiences of other engineers who have made such changes and the precautions necessary to overcome the difficulties*—A. A. B.

Higher Rating Likely With Oil

REGARDLESS of the type of boiler referred to by A. A. B., the performance of an oil fire will depend largely upon three factors: 1—furnace volume, 2—flame location and turbulence, 3—rate of heat release per unit of furnace volume. When an oil-burning system is installed in a hand-fired furnace, it must be considered that a much higher heat release, with proportionately higher furnace temperature, is likely to occur. Even though the same evaporation rate is maintained, the sensitivity of an oil fire makes it easily possible for an operator to increase the combustion rate in too great proportion to the rate of evaporation increase on variable loads. This procedure often results in excessive furnace temperatures. A good system of automatic combustion control, together with intelligent operation, will eliminate it.

With an H. R. T. boiler, the furnace volume may be increased by either dropping the furnace floor level or raising the boiler. Drum should be 48 to 60 in. above the furnace floor, depending on the size of the boiler. No bridge wall is needed with oil burners. The center line of the burners should be 8 to 12 in. above the furnace floor and the guns should point slightly down-

ward. When the burners are correctly adjusted, this position may be checked by the flame position. The tip of the flame, on full load and proper draft, should be at about half the height of the furnace and between half and two-thirds of the furnace length.

In operation, the temperature and oil pressure are the two important variables. In control of these factors, proper atomization will result and by keeping the proper fuel-air ratio efficient combustion should be attained with little trouble from refractory damage.

An approximate rule for checking up on furnace volume is to allow at least one cubic foot of space in the combustion chamber to each pound of oil fired per hour at maximum rating. Maximum rating is interpreted with this rule as that rating which will be carried for at least an hour at a time, not temporary peaks.

Waterville, Me. HARRY M. SPRING, JR.

Advise Boiler Insurance Company Before Change to Oil

THE first thing A. A. B. should do is to notify the insurance company covering his boilers to find out if they are in suitable condition to burn fuel oil, then take the matter up with the boiler manufacturers, advising them the rating he wishes to secure from the boilers under the new conditions. Any good builder will be glad to furnish drawings showing the proper dimensions for any rating, without charge.

Long Island, N. Y. H. P. BREARLEY.

Overload Causes Trouble

THERE is no reason why it should not be possible to burn oil under any boiler, new or old, that is in good condition, but the application must be suitable for the individual job. Damage to old boilers or settings as a result of changing from coal to oil fuel would not be due to the mere fact that a liquid fuel was used instead of a solid, but to other features introduced during the change-over.

When burning coal, there is a supply of fuel in the furnace that is consumed at a rate depending upon the amount of air supplied. The air passes through the fuel bed, and in so doing it becomes intimately mixed with the combustible matter. With oil fuel, the air and oil are supplied to the furnace only as required, and space must be provided for their intimate mixing while in suspension in the furnace. This means that for equal outputs a furnace must have considerably greater volume for oil than for coal. It is easier to overload the oil-fired furnace than it is the coal-fired one, more especially if the coal furnace operates under natural draft. Any furnace overloaded under oil firing to get a greater output from the boiler will certainly show signs of distress as a result of the overload. The overload does the damage, not the oil.

An oil burner of a type unsuitable for the shape and size of furnace concerned may allow heavy flame impingement on the furnace walls, and this will cause rapid failure of the brickwork. In the same way, flame impingement against the tubes or shell of the boiler may cause trouble.

To sum up, oil firing if properly applied so that the furnace is not overloaded and there is no harmful direct flame impingement, should cause no more wear on brickwork and boiler surfaces than coal firing, and in many cases it will cause considerably less.

Adequate furnace volume is the first essential, and this is dictated entirely by the amount of fuel which is to be burned, which again is governed by the total output of steam required.

Drummundville, Que. C. E. OLIVE
Chief Engineer,
Canadian Celanese, Ltd.

Select Oil Burner Carefully

A SATISFACTORY CHANGE can be made from hand-fired coal to oil firing without disastrous results to the boiler or boiler setting, provided consideration is given to selection of the oil burner and its installation. Lack of definite information makes it rather impossible to offer details relative to an installation applicable to this particular project.

Three paramount issues are generally considered in a change from hand firing to either automatic-stoker or oil-burner methods; saving in fuel, reduction of boiler-room labor and increase in boiler steam output. To generate a greater volume of steam it should be remembered that the combustion rate must be increased, liberating more heat in the furnace.

Several items should be considered carefully prior to adoption of a definite program. (a) Atomization of oil must be perfect: this requirement will be provided in proper selection of oil-burning equipment. (b) Atomized oil must be brought into immediate contact with sufficient air and its thorough mixture with the air assured. Air volume must be controlled and kept at a minimum for proper CO_2. A simple device for interconnected air and oil control can be provided to maintain the desired air-oil ratio. (c) The boiler furnace should be so designed and altered as to maintain temperatures essential to practical efficiencies and to complete combustion of the gases before they come in contact with the heating surface. This requirement is generally met by providing furnace volume in relation to the heat liberated and furnace length for required flame travel. (d) The oil burner should be located in relation to the boiler surface and furnace walls to prevent localization of heat.

Conversion to oil firing will permit use of the present ashpit to augment furnace volume. The present practice of oil burning, in common with the firing of other fuels, has a tendency to increase furnace volume as a result of a demand for higher boiler capacities.

Especially with mechanical-atomizing burners where the floor is subjected to high temperatures, care should be taken to prevent transfer of heat to the foundations. A minimum form of floor construction would provide 5 in. of first-quality firebrick laid on 2 in. of best-grade insulating blocks.

Toledo, Ohio. CHAS. F. HOFFMAN.

Uses Oil to Supplement Wood Waste

I HAVE CHARGE of a steam plant, operating several H. R. T. boilers and one water-tube boiler. These boilers have been fired with sawdust and shavings for about thirty years. Several years ago, on account of the shortage of wood waste, we equipped four of the H. R. T. boilers for burning fuel oil, using oil during the winter season and changing back to sawdust again during the summer when there was usually a surplus of this fuel.

The boilers equipped for burning oil are 60 in. x 16 ft. with a dutch oven furnace extending about 8 ft. out in front of the boiler. The burner used is a steam-atomizing type. When we wish to change over to oil, we lay a checker work of firebrick over the grates and build up a temporary firebrick wall about 18 in. inside the fire doors and across the furnace. This is done to get the burner farther in and nearer the boiler. The cast-iron doors are taken off and a steel-plate door with suitable openings for burner and peep hole is bolted on. The burner extends through this door and through the false brick wall, the tip being placed about 5 in. above the brick checkerwork. Two to three hours are required to install burner and brickwork. Also the boiler has to be shut down over night in order to cool off before the change can be made. When changing back from oil to sawdust, the work can be done in an hour or less. In fact, it has been done many times during the noon hour without interruption in service by raking out the hot bricks with a hoe.

When burning sawdust in these boilers, we carry the stack draft at 0.20 to 0.45 in. of water. When we started burning oil, we carried about the same draft.

After burning oil for several weeks, we noticed some of the bottom plates on the boilers beginning to bulge, apparently from overheating. They were examined and found to be quite clean inside. Also the burners had always been carefully adjusted so that the flame did not impinge directly against the boiler plate. The cause was rather puzzling. We cut the draft down to 0.30 in. and operated for some time that way, watching the boilers closely. The bulging continued, although to a lesser degree. We cut the draft down to 0.25 in., and after several months operation, the bulging had apparently stopped completely. We cut it down another 5 points for safety, to 0.20 in., and have been operating that way for about four years with no further trouble. We have a strict rule in the boiler room, and adhere to it, that no one is to operate the boilers with over 0.20 in. draft when burning oil. If we cannot carry the load with this draft, we steam up more boilers or carry more of the load on the sawdust burners. Trying to force the boiler by admitting more oil only causes the fire to smoke, but will not concentrate enough heat in one place to damage the plates.

I do not mean to say that 0.20 in. draft is the proper draft for A. A. B. to carry on his boiler, but merely offer as a suggestion the fact that the draft gage can be used as a guide to keep a close check on the fire and keep it within safe limits.

As far as damaging the setting is concerned, we have had no more trouble when burning oil than when burning sawdust. This depends principally on the size and shape of the combustion space and the location of the burners. If the burner is placed too near the furnace wall, or the flame impinges directly against a wall, trouble can be expected. This also holds true regarding the heating surfaces of the boiler. These are details that will have to be worked out by A. A. B. himself, as no definite rules can be given here because

so much depends on the size and type of boiler and other conditions.

Probably the most important thing of all is to keep the inside of the heating surfaces clean, especially the bottom shell plates of an H. R. T. boiler or the two bottom rows of tubes if it is a water-tube boiler. If there is a bridge wall in the furnace, it may be advisable to remove it entirely, or at least cut it down, as it will act as a deflector and throw the flame up directly against the boiler plates. In the boilers mentioned above we removed the bridge wall entirely, the flame having a clear sweep horizontally from burner tip to rear wall, a distance of approximately 24 ft.

Pittsburg, Calif. M. L. LINCOLN
Chief Engineer
Redwood Manufactures Co.

Avoid Flame Impingement

WITH PROPER CARE and knowledge of conditions, there should be no trouble with either boilers or brickwork due to converting from hand-fired coal to oil burning under an old boiler.

There are three operating conditions to watch:—

(1) *Flame impingement.* Where the burners are so crowded that impingement of the flame on the side walls of the furnace results, there will be constant spalling and erosion of the brickwork. This may be avoided by either aiming the line of fire of the burners toward the center of the furnace or by building a 2½- or 4½-in. "dummy" free-standing fire brick wall to take the erosion, thus saving expensive renewals or patching of the bonded firebrick wall.

(2) *Hot spots.* Should the flames or high temperature gases be in contact with a concentrated area of the bottom row boiler tubes, failures will result unless the tubes are kept scrupulously clean of scale (which should be a usual condition). Frequently, a relatively slight change in bridge wall and baffle locations will result in better gas flow with consequently better heat transfer, efficiency and less likelihood of tube failure. It would be wise to solicit the advice of the boiler manufacturer for his experience on this problem.

(3) *Forcing.* The comparative ease of firing oil over hand-fired coal often leads to forcing the boiler beyond an economic point of operation. Obviously more trouble with maintenance will be found in a boiler operating at 200 per cent than in one operating at 100 per cent, regardless of the type of fuel used. Where the increased rating is found desirable or necessary, care must be taken to insure scale- and soot-free tube surfaces, and well constructed and maintained brickwork.

New York, N. Y. JOSEPH W. DEGEN

Which Depreciates More Rapidly, Steam or Diesel Engine?

ANSWERS to January Question 2

THE QUESTION

BECAUSE *of the high efficiency of a diesel engine, it is, in my opinion, less likely to become obsolete than a steam boiler or turbine. Do other readers agree with me in this? That brings up the question of straight depreciation. What is a reasonable life for a diesel engine, based on the actual experiences of* POWER *readers?*—F. B. W.

Wait Another Fifty Years

SOME YEARS AGO, when gasoline engines were in general use in fishing vessels and other craft on Puget Sound, not many engines were more than five years old. A 10-year-old engine was a rarity. And please note that these engines were of the real heavy-duty type, weighing something like 100 lb. per hp.

One of the great drawbacks with the diesel is its outrageous first cost. Because it would probably have been necessary to install a new boiler, a triple-expansion marine engine was replaced with an 8-cyl. 2,200-hp. diesel at a cost of $220,000. The steam engine had only three cylinders. It was also necessary to install a 250-kw. generating set, diesel driven, and an elaborate cooling system with a number of motors, pumps, tanks, coolers, and copper piping, as sea water is not used. When the writer made a trip on this vessel, there were two men on each shift to look after these auxiliaries, besides the men on the main engine. It will probably take the diesel nearly 25 years to pay for itself with its saving in fuel over a steam engine of the same horsepower, but how much will be left of it by that time? Even if still running I think it is safe to say that it will be just about ready for the scrap heap. If so, where does this alleged saving come in?

The first diesel on Puget Sound was installed in a small passenger vessel in 1912. After breaking a couple of crankshafts, besides other continuous trouble and delays, it was finally scrapped after about ten years of use. How much did the owners save in this case?

There are steam engines still running today that are 50 to 75 years old. The diesel enthusiasts in many cases do not seem to take such facts into consideration. If they would they might possibly discover that it would knock a big hole in their alleged savings.

The real and true story about the diesel has not yet been told. Nor can it be until another 40 to 50 years have gone by.

Seattle, Wash. ALFRED KENNEDY

Don't Compare Engines, Compare Plants

THE diesel engine as a self-contained unit performs all the essential functions of the complete steam plant, boiler, turbine or engine and auxiliaries, in so far as conversion of the potential heat energy of the fuel into mechanical energy is concerned. Hence, the only fair basis of depreciation comparison is the complete diesel plant against the complete steam plant; not the diesel engine against the steam turbine or engine alone.

The reasonable life for a diesel plant may be conservatively estimated, from performance records of plants in actual existence. Following are two typical, and by no means unusual, examples of diesel plant performance of which the writer has personal knowledge based upon actual experience.

Example I. Two diesels in an electric generating station, one rated 365 hp. the other 520-hp., both vertical, 4-cyl., 4-cycle, air-injection units direct connected to alternators and exciters. Installed in 1921 and until 1926 were the only units in the plant, which has since been tripled in capacity.

During the first five years of their life, each engine operated approximately 60 per cent of the possible running time, the last seven years approximately 35 per cent of possible running time. In the winter of 1929-30, eight years after installation, these two engines were carefully inspected, at which time the maximum cylinder wear in the eight cylinders ranged from 0.033 to 0.045 in. As yet (Jan. 1934) neither of these engines has ever had a cylinder rebored, a new piston fitted, a crank or main bearing replaced, with the exception of one cylinder damaged by accident shortly after installation.

These engines consistently, year in and out, deliver from 10 to 10.5 kw.-hr. at the plant switchboard per gal. of fuel; the fuel economy being practically as good as for the later and larger units installed in 1926 and 1929.

Example II. Three engines in an electric generating station, two rated 90 hp. each and the third 180 hp., all horizontal single-cylinder, 4-cycle, air-injection units belted to alternators and exciters. The two 90-hp. units were installed in 1911, the 180-hp. unit in 1916 and carried the electrical load in this small plant until 1929 when the capacity was increased by the installation of a 240-hp. natural gas engine.

These three diesel engines are still in regular service, and year by year are delivering at the plant switchboard from 8.1 to 8.5 kw.-hr. per gal. of fuel, and maintenance costs are not excessive. Certainly a creditable performance for really old diesels belted to generators and exciters and operating under rather poor load conditions.

These three diesels of ancient vintage are owned and operated by a small city that has the unique distinction of having no city taxes, the net earnings of the electric and water department defraying all capital costs and the greater part of the operating costs of the municipality. (City of Clayton, N. M.)

It has been the experience of the past twenty years of diesel engine operating history that few stationary units built by the better-known diesel manufacturers have "worn out" when intelligently operated. Rapid increase in power requirements has resulted in the removal and often in junking of small units installed years ago.

In recent years, great progress has been made in the design and construction of diesel engines, and of course no really modern diesel has yet been in service long enough to demonstrate conclusively its reasonable span of life. But judging from the performance records of many diesels built ten to twenty years ago, and taking into consideration the great improvements in modern engines, it does not seem that an estimated life of 25 years is excessive for the modern diesel engine.

Oklahoma City, Okla. J. H. BENDER

THE ENGINEER'S BOOKSHELF

Chemical Handbook

CHEMICAL ENGINEERS' HANDBOOK (1934)—*—Edited by John H. Perry, Ph.D., chemical engineer of E. I. duPont de Nemours & Co. (Grasselli Chemical Co.) and prepared by a staff of specialists. Published by the McGraw-Hill Book Company, Inc., 330 West 42nd St., New York, N. Y. 2609 pages, 4½x7 in. Illustrated and indexed. Flexible fabricoid binding, india paper. Price $9.*

Intended to supply both practicing engineers and student with authoritative reference data, this handbook covers the field of chemical engineering and important related fields. Sixty contributing specialists prepared the book, with the advice and suggestions of 150 chemists and engineers. It contains costs data and bibliographies in many sections, both immensely valuable. Thirty sections comprise the work, many of them of interest to power engineers, particularly to those who also supervise process work. Sections of particular interest include: Mathematical Tables and Weights and Measures, Mathematics, Physical and Chemical Data, Physical and Chemical Principles, Flow of Fluids, Heat Transmission, Evaporation, Humidification, Dehumidification, and Cooling Towers and Spray Ponds, Gas Absorption, Adsorption, Distillation, Drying, Crushing, Grinding and Pulverizing, Measurement and Control Process Variables, Materials of Construction, High-Pressure Technique, Movement and Storage of Materials, Fuels, Power Generation and Mechanical Power Transmission, Refrigeration, Electricity and Electrical Engineering, Accounting and Cost Finding, Safety and Fire Protection, Reports and Report Writing, Patents and Patent Law.

Even casual consideration of these section headings indicates the monumental nature of the work. Throughout, the work is excellently presented and carefully done by men who are acknowledged leaders in their specialties. It should find a useful place in the library of the practicing engineer faced with chemical as well as power problems.

Boiler Code

A. S. M. E. POWER BOILER CODE (1933). *Formulated by the Boiler Code Committee. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y. 314 pages, 5½x8 in., clothboard covers. Illustrated. Price $2.50; to members $2.00.*

The 1933 Edition of the Boiler Code is particularly important because it contains revisions permitting unlimited use of fusion-welded shells and drums, provided certain requirements necessary for safety are met. Rules and requirements are given by the Code in detail.

As a result of co-operation with the A. S. T. M., many revisions have been made in the Material Specification Section. Some of the specifications have been made identical with those of the A. S. T. M.; certain new specifications have been added. The Boiler Code Committee has also accepted revised A. S. T. M. specifications for flange-quality steel plate for forge welding, to include fire-box quality.

There are four sections: Power Boilers, Material Specifications, Rules for Inspection, and an appendix which is explanatory of the Code and contains material not mandatory unless referred to in the rules of the Code.

Modern Hydraulic Power

ELEMENTS OF HYDRAULIC POWER GENERATION (1934). *By Arthur M. Greene, Jr., dean of School of Engineering, Princeton University. Published by John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd., London, England. 58 pages, 6x9 in.; 48 illustrations. Cardboard cover. Price $1.00.*

This little book is intended to supplement, in the hydraulic field, the author's, "Elements of Power Generation." Its purpose is to give young engineers and laymen some knowledge of apparatus used in hydraulic-power developments, and for upperclassmen a supplement to a course in theoretical hydraulics by showing the application of modern structures. In general, the text is descriptive of modern hydraulic power machinery and the reasons for these designs, without the use of mathematical discussion except where necessary to explain.

Thermodynamics

TECHNICAL THERMODYNAMICS (1933)—*By Prof. Dipl. Ing. W. Schüle. Translated from the German "Technische Thermodynamik" by E. W. Geyer, University of Glasgow. Published by Sir Isaac Pitman & Sons, Ltd., London, England, or Pitman Publishing Corp., 2 W. 45th St., New York, N. Y. 627 pages, 6x9 in. Clothboard covers, one with pocket containing 3 tables. Also steam tables (abridged). Indexed. 324 diagrams. Price $10.*

Extensively used in technical schools throughout central Europe, this first volume of Prof. Schüle's has now been translated into English. It presents thermodynamic problems from a new angle and also surveys results of recent German experimental work, including much material of exceptional interest in research.

The first six chapters are devoted mainly to the laws of gases, therefore are applicable to internal combustion engine problems. The remaining four chapters deal with the properties of steam and other vapors. Most units have been converted to English measure. Chapter headings include: Gases, Thermal Properties of Gases, First and Second Laws of Thermodynamics, Flow of Gases, Deviation from the Ideal Gas State, Special Applications of the Gas Laws, Steam at Normal Pressures, Steam at High Presures, General Relations for Vapors, Applications.

BRIEF REVIEWS

PERFORMANCE AND TEST STANDARDS FOR SELF-PRIMING CENTRIFUGAL PUMPS (1933). *Published by The La Bour Company, Inc., Elkhart, Ind. 30 pages, 5x8 in. Paper cover. Illustrated.*—Published as a handbook on the performance, testing and operation of self-priming centrifugal pumps, this little book is a valuable contribution to pump literature.

MAP SHOWS CROOKED COURSE OF NEW RIVER. *Issued by the United States Geological Survey, Department of the Interior. Price $0.10*—Topographic map of Independence quadrangle, in Grayson County, southwestern Virginia, showing the tortuous course of the New River, on which hydro development is planned.

INDIVIDUAL AND COLLECTIVE BARGAINING UNDER THE N.I.R.A. *Published by the National Industrial Conference Board, Inc., New York, N. Y. Price $1.00*—A nation-wide survey of the extent to which industrial employees generally have availed themselves to the statutory right conferred by Section 7(a) of the N.I.R.A.

OUTLINE OF MANUFACTURE AND PROPERTIES OF STIFF-MUD FIRE-BRICK. *By E. H. Van Schoick, vice-president, Chicago Retort & Fire Brick Co., Ottawa, Ill. Technical Bulletin No. 45, dated December, 1933, of the American Refractories Institute*—Copies may be obtained by addressing S. M. Phelps, Refractories Fellowship, Mellon Institute, Pittsburgh.

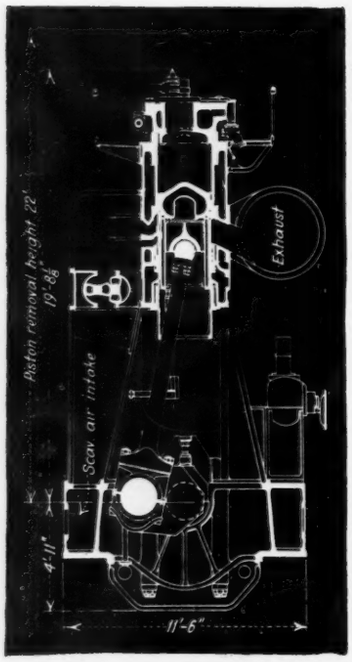
1933 A.S.T.M. MANUAL ON PRESENTATION OF DATA (WITH TABLE OF SQUARES AND SQUARE ROOT). *Published by the American Society for Testing Materials, Philadelphia, Pa. 45 pages. Price $0.50*—Prepared by a special committee of engineers. Also contains given methods of computation, etc.

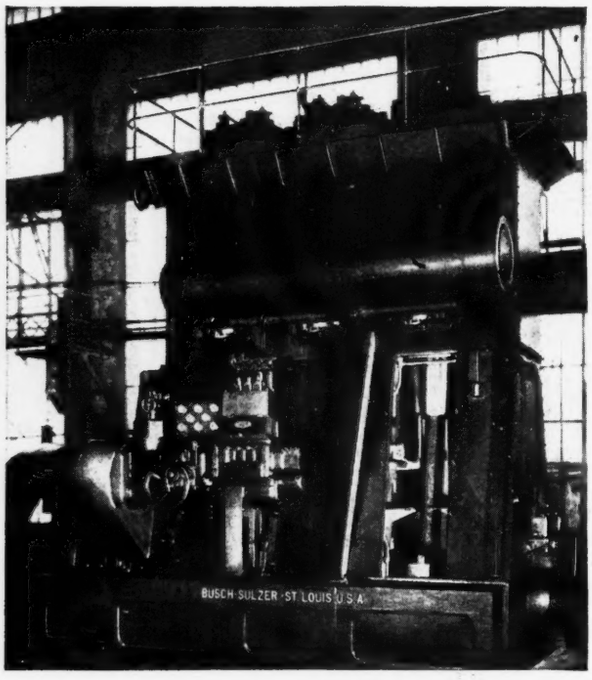
ANTHRACITE AND COKE ANALYSIS SURVEY CONDUCTED AT THE FUEL RESEARCH LABORATORIES. *Issued by the Department of Mines, Ottawa, Canada*—Results of analyses of 86 samples of different sizes of anthracite coals and domestic cokes marketed in Ottawa during the winter of 1932-33.

"THE ENGINEER" DIRECTORY & BUYERS GUIDE (1934-35). *Index of British manufacturers. Technical vocabulary in French, German, Italian and Spanish. Telegraphic addresses and codes. List of British standard specifications and reports. Published by "The Engineer," 28 Essex St., Strand, London, W.C.2, England*—Issued annually to advertisers. A handy booklet for companies interested in English business.

WATER-WORKS MACHINERY DEVELOPMENTS. *By A. Peterson, chief engineer, DeLaval Steam Turbine Co., Trenton, N. J. Reprint of a paper before the annual meeting of the American Water Works Ass'n in Chicago*—A general review of economic developments.

WHAT'S NEW IN PLANT EQUIPMENT





Large Trunk-Piston Diesels

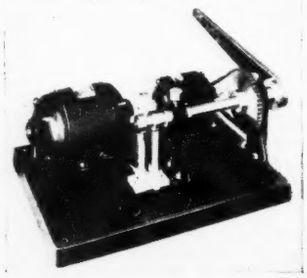
Largest trunk-piston diesel so far built, this unit follows design of company's 19½x27-in., 2-cycle, single-acting engine fitted with A.E.G. mechanical injection, brought out in 1930. In units up to 12 cyl., with rating of 10,000 b.hp. Low piston dismantling height made possible by equipment permitting connecting rod to be disconnected from piston pin within crankcase; thus connecting rod and crank bearings are undisturbed when piston is removed. Separate piston-pin housing provides full-length bearing for pin. Scavenging air supplied either by an independent turbo-blower or Busch-Sulzer positive-displacement rotary blower (as shown in cross-section) and gear-driven from engine shaft. Fuel consumption per gross b.hp.-hr. runs between 0.335 and 0.347 lb. Cross-section is of 30x52-in. unit, rated 750 b.hp. at 120 r.p.m. Front view of 3-cyl. unit shows door swung open, exposing piston for about 75 per cent of its length. Unbroken piston skirt surface, reducing friction and avoiding distortion. Annular open chamber to permit easy piston inspection during operation. C.I. packing rings above and below this inspection chamber, held in place by bolted glands, keep crankcase oil separate from cylinder oil. Siudge chamber below combustion chamber results in longer piston, which, guided by scraper rings, eliminates vibration and tendency toward piston slap. Elimination of crosshead reduces height and weight of engine by one-third. Bulletin Form 836.

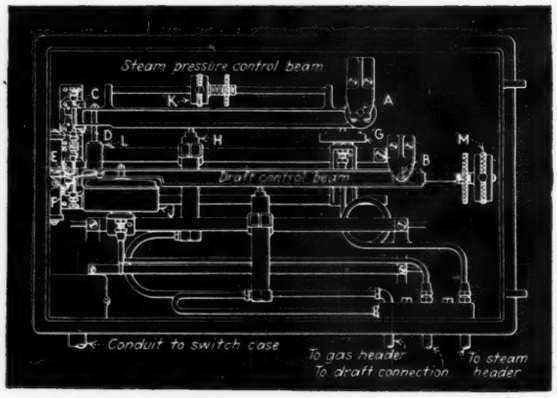
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo.

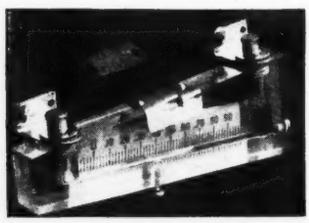
Automatic Combustion Control

DFC proportioning, control provides continuous, immediate adjustment of fuel and air. Controls fuel input by balancing gas pressure at burner header with steam pressure in boiler; controls proportions of fuel and air by balancing furnace draft with gas pressure in burner manifold. Neither steam pressure nor relation between fuel and air are affected by variations in line gas pressure or stack draft. Steam pressure maintained constant within limits of 2% plus or minus. Model GND operates on boilers under natural or induced draft and fired with atmospheric gas burners. Also models for use with boilers fired with other fuels and forced-draft, gas-fired installations. May be applied to single boiler or to many boilers when in battery and discharging flue gas to common breeching. Three main parts: Steel control panel for floor mounting, 32 in. wide, 6 ft. high, with control instrument diagrammed mounted in it. Damper-operating mechanism (photo). Motorized gas valve. Control instrument case contains two beams on anti-friction bearings at *A* and *B*. Opposite ends of beams are between electric contacts *C* and *D*, *E* and *F*. Under each beam are two pressure elements, *G* and *H* operating upper, and *I* and *J* lower, beam. Position of *H* and *J* adjustable, as are weights *M* and *K*. Steam pressure control beam (upper) maintains steam pressure by controlling fuel input. Draft control beam (lower) controls air by regulating damper. Normally contacts *C* and *D* are open. Demand increases, causing steam pressure drop and relieving pressure in *G*, allowing beam to move downward and close contact *D*. This opens motorized gas valve. Element *H*, connected to burner manifold, is expanded as gas valve opens, thus balancing beam between contacts again. When fuel input is increased, element *I* (connected to manifold) expands, disturbing balance of draft-control beam and closing contact *E*. This contact, through suitable relays, starts damper-operating mechanism. *J*, connected to boiler furnace over fire, has increased negative pressure due to higher draft, thus offsetting positive pressure in *I* and rebalancing beam. Damper-operating mechanism in photo consists of electric motor driving countershaft through reduction gear, chain and sprockets. Lever on one end of countershaft operates damper, limit switches at other end control motion. Two sizes, one with shaft torque of 100, other 500 ft. lb. Bulletin 320.

Denver Fire Clay Co., Denver, Colo.



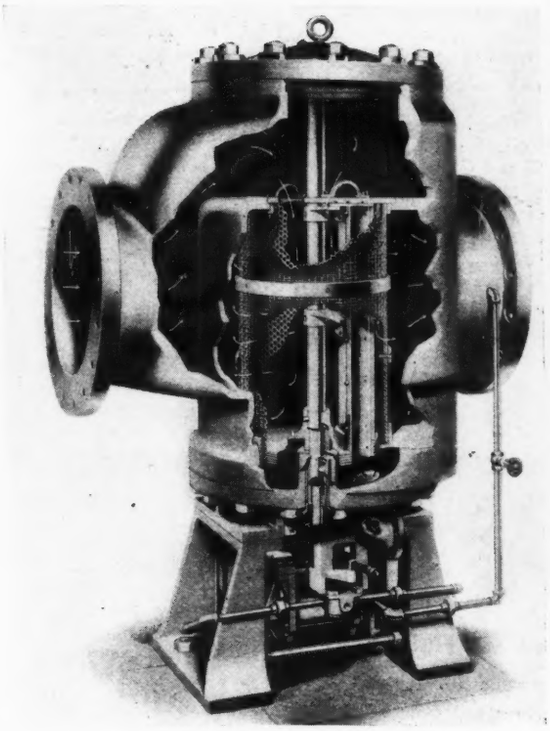




Transparent Draft Gage

Bakelite transparent resinoid. Tube and oil chambers accurately reamed in solid casting. All parts fully visible and leveling bubble free from shadow. Range — 0.10 to + 1.0 in. draft.

F. W. Dwyer Mfg. Co., Chicago, Ill.



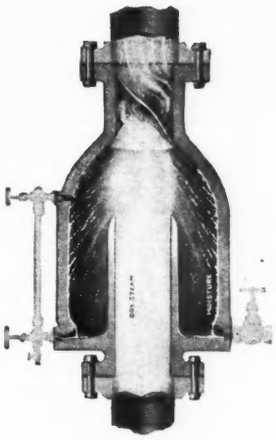
Self-Cleaning Strainer

Will clear service water of extraneous matter down to quite small particles, yet does not need frequent cleaning. Self-cleaning mechanism operated by self-contained water motor taking water from outlet side of strainer. Water flow shown in illustration by white arrows; black arrows show back-washing action which carries dirt down hollow scraper and out to drain. Water flows into strainer basket, made up of three thicknesses of perforated plate or mesh. Inside is plate ⅛ in. thick with round perforations, outside is No. 3 mesh wire frame, with No. 28 Monel-metal wire cloth (0.02-in. openings) between. Outer stronger layers protect fine mesh cloth which removes small dirt and débris. Revolving scraper with double edge fits closely inside basket. Scraper attached connected with water-motor shaft at bottom and supported at top by spider. V-shaped, with adjustable plates extending length of basket, set to minimum clearance. Strainer basket easily removed for cleaning; pressure drop through it is low. Sizes from 4 to 24 in., for 125-lb. working pressure.

Elliott Co., Jeanette, Pa.

Separator

Utilizes "helico-centrifugal" principle, with helix or "corkscrew" device near inlet of separator. This device gives entering steam, air or other vapor a whirling motion, throwing out liquid or solid matter by centrifugal force to outside, where it collects, runs down and is drawn off. No baffle plates or other devices employed that have a tendency to reduce pressure. Available in all usual sizes, styles and capacities. Prevents knocking, slugging and freezing of air lines.

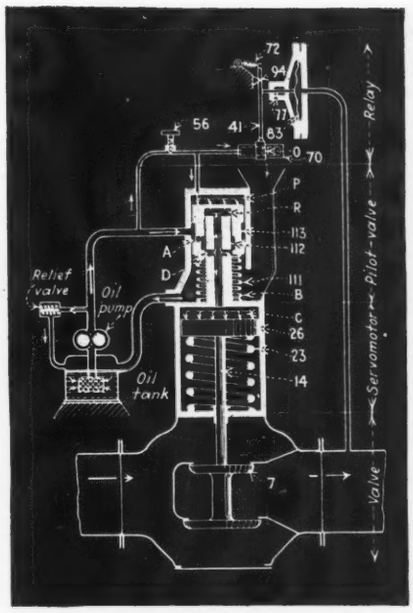


Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

Automatic Regulating Valve

AVA Regulator, integral part of Ruths Steam Storage System, is now being offered separately. It functions by indirect method, thus enabling a small power impulse to control large steam valve. Oil actuated; all moving parts enclosed, special hydraulic return motion to eliminate hunting. Adjustable during operation. Also has hand-operating device and adjustable valve-speed control. One valve, with several impulses, can be controlled from different pressure lines. Servomotor consists of piston 26 and spring 23. Oil pressure at *C* on top of piston balances force of spring. Pilot valve consists of spring 111 and piston 113, with oil pressure *P* balancing spring force. Functions thus: If steam-line pressure is constant, regulator is in equilibrium. Any pressure change causes deflection of diaphragm 83, transmitted through rod 77 to lever 41 which swings on fulcrum 94. Lower end of lever 41 controls oil flow through *O* in pipe nozzle 70, which in turn regulates oil pressure *P* on top of pilot-valve piston 113. An increase in *P* drives piston down, thus permitting more oil from *A* to pass into spaces *D* and *C*. Oil pressure *C* is thus increased and drives servomotor piston 26 down, opening main steam valve. Return motion or stabilizer functions thus: Oil in space *C* is connected directly to space *R* under pilot piston 113. When 113 moves down to increase oil pressure in *C* it also increases pressure in *R* to same degree. Increased pressure in *R* drives piston upward again and cuts off supply of oil from *A* through *D* to *C* and *R*. When equilibrium is reached, servomotor comes to rest in position corresponding to required valve setting.

Ruths Steam Storage, Inc., 270 Madison Ave., New York, N. Y.



Controller

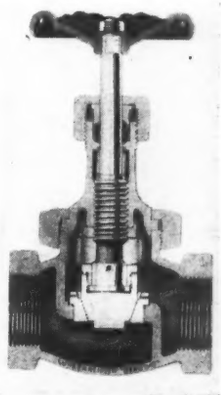
Two types, one pressure, other temperature, particularly useful where dependable control at definite control point must be had inexpensively. Dial and knob on lower face permit adjustment of temperature or pressure within instrument range. Indicating gage above shows air pressure on diaphragm motor of control valve and also shows whether valve is opening or closing. On temperature controller, 2-in. dial-type thermometer may be installed in place of air gage. This thermometer is connected to same bulb as controller, thus showing the temperature being maintained. Pressure controller may be equipped likewise with high-pressure indicating gage showing pressure being controlled. In either case, it is necessary to mount a valve motor air gage on air line to valve outside case.

Universal case designed for either flush or surface mounting. Connection may be either top, bottom or back. All working parts integral with or mounted on cast-aluminum base. Temperature controller is Type 1119 and the pressure is Type 2119.

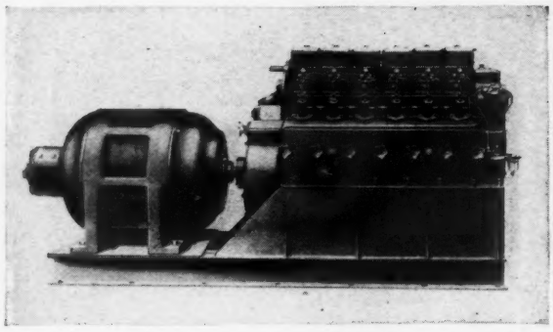
Foxboro Co., Foxboro, Mass.

Plug-Type Valves

For severe service demanding maximum resistance to destructive action on valve-seat bearings. Iron body, bronze mountings (Ferrenewo) for 150 lb. S.P., bronze (Renewo) in 200-lb. and 300-lb. S.P. patterns. Except for bodies and rings, parts interchangeable. Booklet 541-A.



Lunkenheimer Co., Cincinnati, Ohio.



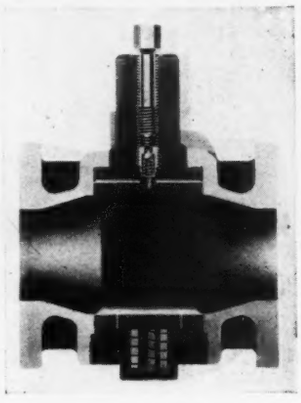
Four-Cycle Diesel Engine

Available in 1-, 2-, 3-, 4- and 6-cyl. sizes, with capacities of 10, 30, 40 and 60-b.hp. 4½ x 6-in. cyl., normal operating speed 1,200 r.p.m. Displacement 85 cu. in. per cyl. and 5,370 cu in. per min. per hp., at rated speed. Cylinders in multi-cylinder engines cast en-bloc. Cover plates on lower base facilitate service and inspection. Removable cylinder liners. Cylinder heads water-jacketed. Injection timing control. Lubrication force feed throughout. Alloy intake and exhaust valves operated by push rods from camshaft totally inclosed in engine crank case and pressure lubricated. Also carries fuel-injection cams, one per cylinder. Cooling water circulated by reciprocating plunger-type pump driven from camshaft at half engine speed. All pump connections readily accessible from outside. Fuel pumps of individual mechanical-injection type with fixed stroke and variable inlet cut-off, mounted directly beside each cylinder, with short, equal-length connections to nozzles. Nozzles of single-orifice type, removed easily for inspection. Flyball-type governor of special design permits wide speed range with accurate control. Single-cylinder unit started readily by hand crank. On 2- and 3-cyl. units, 24-volt electric starters can be supplied, but hand cranking is standard. 4-, 5- and 6-cyl. units fitted with complete electric starting systems. For electric generating services, engines are available with either a.c. or d.c. generators, in capacities of 6 to 40 kw.

Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.

Lubricated-Plug Valves

A.C.F. valve is designed to provide well - proportioned, round-cornered full-pipe-area port opening, short lubricant passages, large metal-to-metal head and properly lubricated and sealed line seats. No auxiliary packing. By special arrangement, when lubricant pressure becomes too high, it discharges around neck of plug. In cross-section, lubricant screw at top screws into plug with lubricant check valve below it. Below port opening are baseplate and spring. Oil passages may be seen at side of plug and on upper wearing surface just below check valve. In 125-lb. or extra-heavy 250-lb. lubricated valves with screwed or flanged ends, wrench and gear operated. Also 150-lb. 2-port and 3-way units. Standard sizes. Circular No. 51.

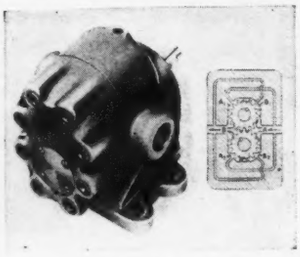


American Car & Foundry Co., Valve Division, 30 Church St., New York, N. Y.

Fuel-Oil Heater

Twin G-fin section, consisting of two parallel steel pipes, each serving as shell for G-fin pipe with return bend at one end and all inlet and outlet connections at other end. G-fin pipe is in U-bend or hair-pin shape, each leg in one of parallel pipes. Standard and interchangeable, units can be arranged in series or parallel and additional sections can be connected at any time. Design eliminates necessity of supplying 100 per cent spare heating capacity except when only one unit is installed. Exterior surface of G-fin elements is eight times that of interior cylindrical surface. Steam is passed inside G-fin, oil flowed along outside. No internal joints to permit leakage of between steam and oil, free expansion of both shell and G-fin to avoid temperature strains, ready accessibility of entire heating surface for cleaning and inspection, light weight.

Griscom-Russell Co., 285 Madison Ave., New York, N. Y.



Gear Pump and Fluid Motor

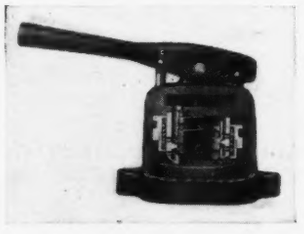
Vickers balanced gear pump and fluid motor cannot bind or "lock." Adjacent to gears and diametrically opposite inlet chamber A are balancing chambers A_1 and A_2 connected to A and open to its pressure. Similarly, balancing chambers B_1 and B_2 are connected to outlet chamber B and are open to its pressure. Each gear is therefore always in hydraulic balance, thus eliminating thrust loads and consequent wear on bearings, gears and housings. When used as motor, can be started under full pressure, and has full torque when stalled. Any unit may be used as pump or motor, and rotation is reversible without internal change. Operates at pressures up to 1,500 lb. per sq. in.

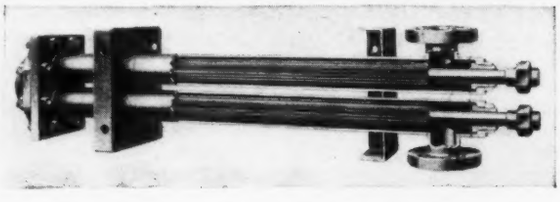
Vickers, Inc., Detroit, Mich.

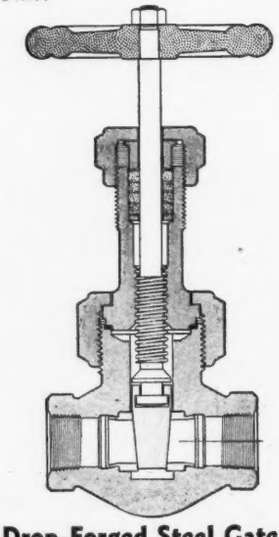
Air-Operating Valve

Utilizes unique design principle. Stainless-steel or brass cylindrical body is drilled longitudinally from each end, leaving solid section between ends of drill-holes. At base of each hole, and opening into it, eight ports are drilled radially around body. Surrounding this body, a sleeve is fitted, holding at each end a circular "U" leather packing. This sleeve slides freely on valve body. In open position, "U" leathers surround rows of ports, one above and one below, allowing air, after entering body at upper end, to pass out of upper row of ports, under sleeve and down through lower row into valve body again. By moving sleeve ⅜ in. toward inlet side, lower packing leather is brought over solid or undrilled section of valve body and air coming through upper ports from inlet side is trapped under sleeve and held by packings. Greater pressure only makes "U" leathers fit more tightly. Closely fitted surfaces of metal or other material not required to maintain tightness. Action is comparable to that of piston pump. Includes standard 3- and 4-way actions, as well as various neutral-position and automatic-return valves in hand-, foot- and solenoid-controlled types. Bulletin 101-V.

C. B. Hunt & Son, Salem, Ohio.



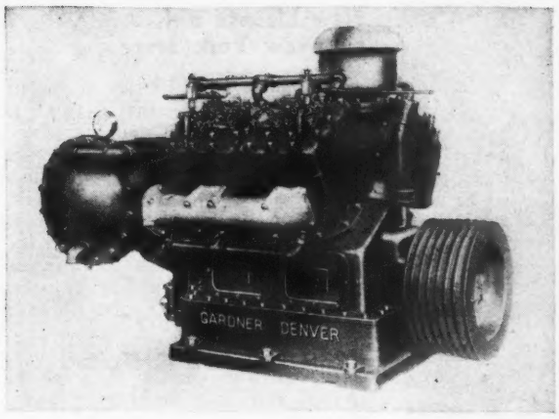




Drop-Forged Steel Gate Valve

This drop-forged steel gate valve with inside-screw stem has union bonnet with either gasket or ground joint as desired. Seats rolled in, may be easily removed while wedge is solid. Sizes from ¼ to 2 in. Designed for oil or steam service up to 600 lb. at 800 deg. F., or non-shock cold working pressures up to 1,500 lb. May be repacked under pressure. Stainless-steel, Nitralloy or Monel-metal trimmings to suit the service. Also several other new types.

Henry Vogt Machine Co., Louisville, Ky.



Vertical Compressors

These verticals deliver the same amount of air as horizontals of the same capacity, but are priced one-quarter lower. Inlet and discharge valves are cushioned, and are silent. Extra large water jackets surround cylinders and valves. Water-cooled intercooler saves power and increases volumetric efficiency. Crank-shafts large-diameter forged steel, supported by three full-circle main bearings of bronze-backed, babbitt-lined type. Pressure feed lubrication to all bearings through drilled passages, thus eliminating all pipes. Rotary oil pump assures constant, uniform oil pressure.

Gardner-Denver Co., Quincy, Ill.

Feed- and Hot-Water Treatment

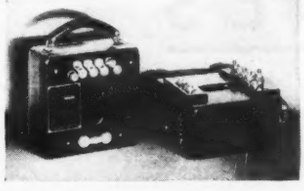
H-O-H Series D formulae are highly concentrated semi-solid organic products for feed- and hot-water treatments. Consist of beta glucoside and sodium glucosate, all combined directly with oxygen to form stable compounds and colloidal gels with calcium and magnesium, thus preventing scale formation. Available in several forms, including sodium phospho-glucosate and sodium ferro-glucosate. Adjustable to meet varying water conditions and supplied in adjusted form following water analysis by company laboratories. Must be diluted before use. In 500-lb. drums only. One pound will treat 60,000 grains of calcium and magnesium hardness for scale prevention.

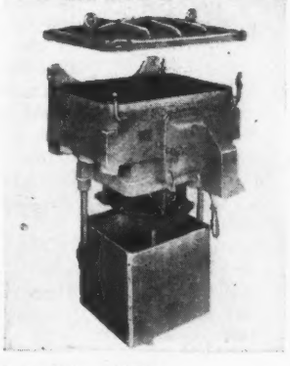
D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.

Portable Current Transformer

For use with indicating and recording instruments. Each transformer has nine primary current ranges of 10, 12½, 25, 50, 100, 160, 200, 400 and 800-amp. capacity. Secondary capacity, 5 amp., adapting unit to use with all standard a.c. ammeters and wattmeters and power-factor instruments. Volt-ampere rating is 25, and transformers are compensated for a load of 15 volt-amps. Thus, transformer can operate several instruments simultaneously at high accuracy. Insulated for use on circuits of all voltages up to and including 2,500. Provided with built-in, secondary short-circuiting switch.

Esterline-Angus Co., Indianapolis, Ind.

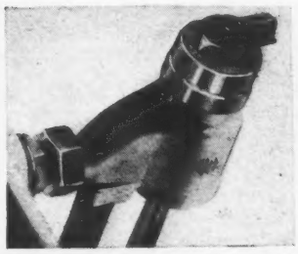




Pole-Line Oil Circuit Breaker

Type P-50 moderate-capacity oil circuit breaker for outdoor distribution service furnished full automatic or non-automatic, manually or electrically operated for 200 and 400 amp., for 2-, 3- and 4-pole single-throw, and full-automatic or non-automatic manually operated 2- and 3-pole double-throw (with or without interlocks).

Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.



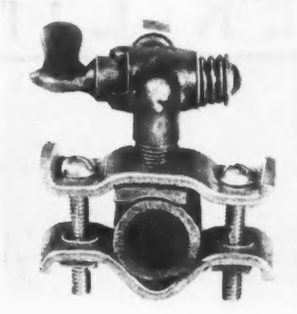
Individual Radiator Valve

Modustat now has manual operating range permitting hand operation from full open to full closed. Also automatic control in range of room temperatures from 60-80 deg. All settings made with single lever. Also units for concealed radiation or for key setting instead of lever setting. All for use on 2-pipe steam systems.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Pressure Connection

Pressure takeoff permits quick, convenient, tight connection to any pressure line of gage, regulator or other pressure-operated device; also small fluid drip lines. Pipe connection is screwed loosely into top



clamp and presses directly against gasket, which in turn presses on pipe. Fluid pressure is transferred through adjustable pilot tube, which is loose in both metal holes but tightly squeezed by gasket. Only tools required are electric drill for drilling pipe and screw driver for setting up clamp screws. Single size clamp shaped to give three-point contact on all pipe sizes ¼ to 1 in.

Walter J. Ottinger, 1893 East 55th St., Cleveland, Ohio.

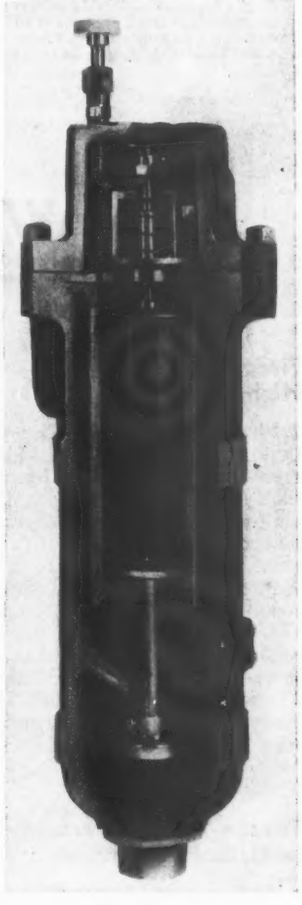
Low-Voltage Cable Terminals

This "standard" line of low-voltage solid-filled cable terminals is suitable for use on single-conductor insulated cables rated at 34.5 kv. or less. Terminals are available for use on paper or varnished-cloth insulated lead-covered power cables of all conductor sizes 2,500,000 circ. mils and smaller. Each unit guaranteed to withstand, without deterioration of insulation, any voltage withstood by standard cable for which terminal is designed. Terminals designed for exclusion of moisture from cable end, to insulate cable end to withstand both switching surges and lightning disturbances on exposed line to which terminal is connected, and to reenforce cable-end insulation.

General Electric Co., Schenectady, N. Y.

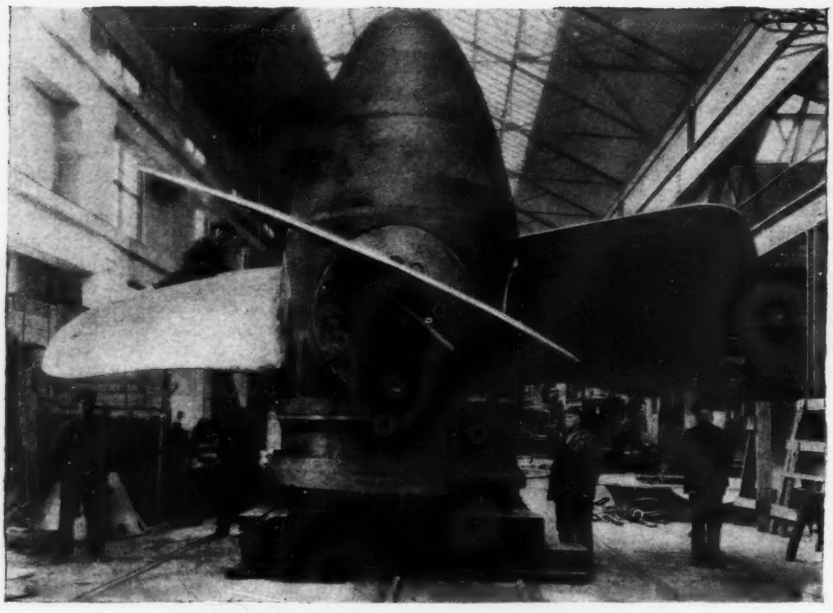
Automatic Separator

Stuard automatic separator is based on principle that freed water, which condenses as compressed air is cooled, will be precipitated if air is suddenly expanded. Automatic vent to atmosphere through separate chamber eliminates precipitate and foreign matter collected by



separator. Eliminator chamber is not a trap, but is open to atmosphere while compressed air is flowing. Separator and eliminator combined in one casting. Entirely automatic. Specially packed chamber eliminates suspended matter not easily precipitated. Sizes from ⅛ to 4 in. I.P.S. Bulletin.

Railway & Industrial Engrg. Co., Greensburg, Pa.



LARGEST HYDRAULIC TURBINE RUNNER

One of two Kaplan type runners for the Vargon plant in Sweden. It is 26 ft. 3 in. in diameter and weighs 150 tons. Operating at 47 r.p.m. under 14-ft. head, it will develop 15,200 hp. Elov Englesson, chief engineer, Verkstaden Kristenhamn, who supplied this photograph, reports that the first unit at Vargon went into operation in January

POWER LINES

Firestone To Add High-Pressure Unit

Firestone Tire & Rubber Co., Akron, Ohio, is planning the addition of a 1,400-lb. pressure unit to burn pulverized coal. It will consist of a Combustion high-pressure boiler to operate at 1,400 lb. pressure and 760 deg. (max.) temperature, supplying steam to a 10,000-kw. G.E. turbine. At the turbine throttle, steam wi be at 1,250 lb. pressure and 750 deg. Exhaust pressure will be 230 to 260 lb. into an evaporator. No steam is to be bled at intermediate pressures. The plant, to cost about $750,000, is expected to be completed in six months after starting.

Fifteen Million Horsepower In U. S. Hydro Plants

The total capacity of water wheels at water-power plants in the United States on Jan. 1, 1934, was 15,913,451 hp., according to the annual report of the Geological Survey. This is an increase during the year of 95,500 hp.

Five states—New Hampshire, Massachusetts, Pennsylvania, Michigan and Wisconsin—show an increase of more than 10,000 hp., while Washington shows a decrease of over 10,000 hp. Some states showed minor decreases due to abandonment or changes in capacity of some plants.

It is estimated that water wheels with a capacity of 80,000,000 hp. would be required to make use of all the potential water power in the United States. At present about 20 per cent of the Nation's water-power resources have been developed.

Six Thousand Extra PWA Applications

When making his accounting of the $3,300,000,000 PWA fund, Administrator Ickes stated that there are still more than 6,000 non-Federal applications for loans and grants pending before the PWA. These represent an amount of $2,900,000,000. Some will be granted because of rescinding of previous allotments.

Waterworks topped the list of 15,000 projects, there being 451 for an allotment of $66,666,972, some 10.6 per cent of the allotments made up to Jan. 10. There were 44 power projects, a total of $48,771,958, or 4.3 per cent of the total on that date.

PWA allotments of $103,875,000 to the Bureau of Reclamation have been distributed over 28 projects. Almost 70 per cent of the total is accounted for by allotments of $38,025,000 for Boulder Dam; $15,000,000 for Grand Coulee; $12,000,000 for Caspar-Alcova; and $6,000,000 for the All-American Canal.

New License Bill for New York State

Applicable to "all cities of one million population or less"—that is to all except New York City—a bill introduced at Albany, N. Y., would add a new article 8 to the General City Law for licensing and regulating stationary engineers. The bill sets up in each city a commission of 3 chief engineers, appointed by the mayor. The bill lists qualifications of a chief engineer as ability to operate a plant above 250 hp.; plus three years experience in charge of plant over 75 hp. A second-class engineer must be competent to take charge of a plant over 75 hp. and have had three years experience operating power units.

Large Equipment Orders Placed by Aldred Companies

Contracts aggregating upward of $1,250,000 for major electrical equipment have been let by Safe Harbor Water Power Corp. and Pennsylvania Water & Power Co. Placing of these contracts follows President Atterbury's announcement that work on the completion of the electrification of the lines of the Pennsylvania Railroad from Wilmington to Washington will be started next week.

Equipment contracts, which were divided between General Electric Co., Westinghouse Electric & Mfg. Co., and others, call for delivery of the largest single-phase water-wheel generator ever built in this country. This generator, which will have a capacity of 42,500 hp., will be especially designed for railroad supply and will be installed in the hydroelectric plant at Safe Harbor. Included also in the contracts is a frequency changer of approximately 35,000 hp. rating.

Expenditures of the three companies of the Aldred group in connection with the electrification of the Pennsylvania Railroad lines from the Susquehanna to Washington, exclusive of the contracts with manufacturers of electrical equipment, will be upward of $4,000,000. A large portion of this money will be spent for labor.

Electricity Production Shows 1933 Gain

A gain in production of electricity during 1933 is shown in the report just issued by the United States Department of Interior. This is the first year since 1929 to show a gain over the previous year. Preliminary figures of the total production of electricity for public use in the United States in 1933 indicate a total output of 85,164,000,000 kw.-hr., an increase of about 2½ per cent over 1932 —83,153,000,000 kw.-hr. Changes in the annual production of electricity are: 1929 was about 11 per cent larger than for the previous year; 1930 was 1½ per cent smaller; 1931 was about 4½ per cent smaller; and 1932 was 9½ per cent smaller. The change from an annual decrease of over 9 per cent to an in-

crease of over 2 per cent indicates a marked change in the demand for electricity in 1933.

Production of electricity by water power was about 1 per cent larger than in the previous year and was 41 per cent of the total, which is the same as for 1932.

The increase in the efficient use of fuels in generating electricity, which has progressed each year since 1919, continued during 1933. The average consumption of coal and coal equivalents of oil and gas in generating 1 kw.-hr. of electricity was 1.47 lb.—0.03 lb. or about half an ounce of coal less per kw.-hr. than in 1932. This saving in coal is equivalent to about 750,000 tons of coal, which at $3 per ton amounts to $2,250,000. Copies of this report may be obtained by application to the Geological Survey, Washington, D. C.

Michigan Saves $60,500 In Institution Power Costs

How sizeable direct savings to taxpayers of Michigan can be effected by close scrutiny of ordinary state operating costs is shown in the recent report of B. J. Abbott, secretary of the State Administrative Board, concerning heating expenses at state institutions. The report notes a saving of $60,500 in fuel and power costs for these 22 institutions for the calendar year ending Dec. 31, 1933, as compared with the corresponding period ending Dec. 31, 1932. Savings in the use of coal accounted for $36,000 of the total. Savings in power costs and fuel oil accounted for the balance.

Operation of heating plants required 8,400 tons of coal less in 1933 (167,000 tons) than in 1932 (175,400 tons).

Savings in power and fuel oil at the new prison at Jackson amounted to $20,000. Savings for the same items reached $4,500 at the Michigan Reformatory at Ionia.

Coal savings at the state institutions reached the peak for the calendar year 1933, in December when there was a decrease of 2,336 tons in the total required for operation of heating plants as compared with the requirements for December, 1932.

These direct savings were made despite a 45 per cent increase in population at Ypsilanti State Hospital since July 1, 1932, the opening of a new Receiving Hospital at Newberry, Oct. 1, 1933, with the incident increase of 25 per cent in the space to be heated, the opening of a new Receiving Hospital at Ionia in Nov., 1932, with an increase of 37 per cent in the space to be heated, and despite also the colder weather that has prevailed throughout this winter.

Practically no new equipment was purchased to bring about these savings. They were effected by stopping steam and hot-water leaks, by maintaining even temperatures, by keeping boilers meticulously clean and by the competing of the various engineers for enviable records of efficient operation of power plants.

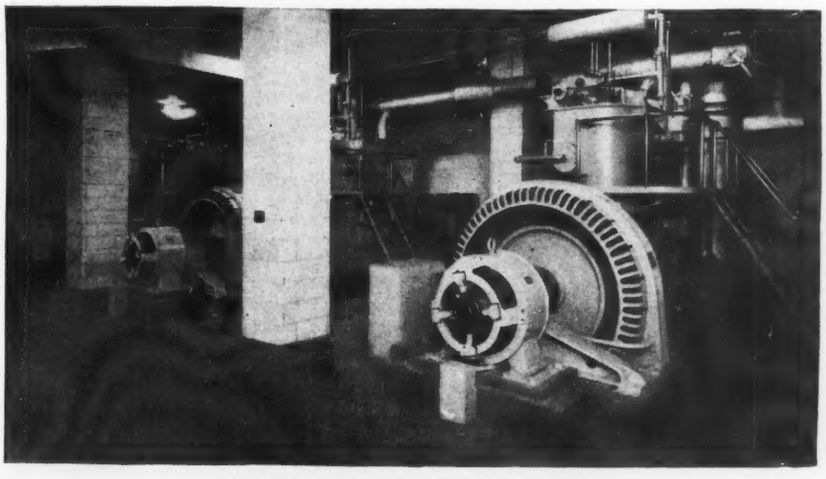
Engineers of state institutions who were responsible for this record under the insistence of Mr. Abbott and R. J. Williams, State Efficiency Engineer, held a meeting at Michigan State College for practical discussion looking to the bettering of the record already set up.

Associated Power Engineers Organize in Wisconsin

The "Associated Operating and Power Engineers" have been incorporated in the State of Wisconsin for the purpose of bringing together engineers for educational betterment, closer cooperation on engineering ethics and engineering civic matters, and protection against adverse legislation as it concerns the engineer. This organization is composed of 175 outstanding Milwaukee engineers who have felt that an organization of this type is greatly needed in the present trend of economic affairs.

Officers are: L. A. Corwin, president; G. M. Rogers, vice-president; F. L. Allen, secretary; K. G. Nelson, financial secretary; P. Evarts, treasurer, and the following trustees: A. Kunz, E. A. Wagner and Gerhard Heisterkamp.

Correspondence should be addressed to F. L. Allen, 4349 N. Morris Blvd., Milwaukee, Wis.



A SHOW PLANT OF THE SOUTHWEST

Engine room and engines in the building of Dallas Gas Co., Dallas, Tex., are kept in spotless condition, and attendants wear white uniforms. Three 165-hp. Bruce-MacBeth gas engines drive alternators at 277 r.p.m. The plant supplies power for the Dallas Gas Building and the Lone Star Building adjoining. Exhaust is run through a Sims economizer, if desired, to supply hot water and heat

COMING MEETINGS

American Society for Testing Materials—Standing Committees, Washington, D. C., March 5–9. Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 25–29. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron & Steel Electrical Engineers—Youngstown, Ohio, April 12. J. L. Kelly, Empire Bldg., Pittsburgh, Pa.

American Institute of Electrical Engineers—Northeastern District meeting, Worcester, Mass., May 16–18. Summer Convention, Hot Springs, Va., June 25–29. H. H. Henline, 33 W. 39th St., New York.

Edison Electric Institute—Atlantic City, N. J., June 4–7. B. F. Weadock, 420 Lexington Ave., New York.

National District Heating Association—25th annual convention, Rochester, N. Y., June 12–15. D. L. Gaskill, sec.-treas., Greenville, Ohio.

American Society of Mechanical Engineers—Petroleum Division, Tulsa, Okla., May 14–16. (Also International Petroleum Exposition). Hydraulic Division, University of Calif., June 19–21. Oil & Gas Power Division, Penna. State College, State College, Pa., June 20–23. Applied Mechanics Division at 4th Intntl. Congress of Applied Mechanics, Cambridge, England, July 3–9. Semi-annual meeting of Society, Cosmopolitan Hotel, Denver, Colo., June 25–28. Headquarters—29 W. 39th St., New York, N. Y.

Power Commission Urges Federal Control

The Federal Power Commission, in its Thirteenth Annual Report to Congress for the fiscal year ended June 30, 1933, strongly urges Federal control over holding companies and affiliated service companies which dominate licensees of the Federal Government under the Federal Water Power Act. Attention is also called to the start of its National Power Survey, a study of the water resources of the Nation as they relate to the conservation, control, and utilization of water power and of the relation of water power to other industries and to interstate and foreign commerce. The survey is also planned to assist in formulating a comprehensive program of public works pertaining to the development of water power and the transmission of electrical energy.

During the fiscal year, the Commission received 36 new applications for preliminary permits or licenses. Seven were for preliminary permits with proposed installation of 2,207,750 hp., 29 for license, including 6 major projects with possible ultimate installations amounting to 196,150 hp.

Penstock Failure Wrecks Lac Noir Hydro Plant

Between 9 and 10 p. m., Jan. 4, the main pipe line to the Lac Noir pump-storage hydro-electric plant in the Vosges mountains, France, ruptured near the plant, and caused serious damage to plant and equipment and the death of

nine people. This plant is being built to operate in parallel with the Kembs hydro plant on the Rhine. When completed, it will have four 40,000-hp. vertical-shaft units, each comprising generator motor, turbine and pump. The plant is on Lac Noir and during off-peak periods pumps water from this lake into Lac Blanc for power generation on daily peaks. The maximum difference in elevation between the two lakes is 394 ft. Further details of this plant are in the table on pages 22 and 23 of January *Power*.

A single tunnel and penstock having a combined length of about ½ mi. and 18 to 15 ft. diameter extended from the upper lake to the power house. At the power house, a branch leads off the penstock to each of the four units. According to information from Escher Wyss Engineering Works, Ltd., manufacturers of the water wheels and pumps and erectors of the penstock, the plant had been in operation since November, 1933. Only two units had been put into service; the other two were under erection. A manhole connection in the distributing pipe failed, due to two internal faults in the material. This caused a rupture 25 ft. long and 8 ft. wide in the distributing section of the penstock. The rupture is not in the welded seams nor does it at any point run parallel to a weld at a short distance from it. The fracture was in a plate 1.4 in. thick which showed perfectly sound metal except for one slight lamination, which was of no importance.

At the time of the failure only one pump was in operation, taking an electrical load of about 8,000 kw. As the guide-vane operating gear on this pump was fixed in the open position, it is considered that water hammer could not have caused the pipe failure.

After erection, the main pipe line, and the distributing pipes, including all valves, connections and the manhole that failed were, as a unit, subjected to a 3-hr. test at twice maximum static pressure, during which all welded joints were thoroughly hammered. The whole conduit system, from the valves at the waterwheels to the intake at the forebay, was one month later again subjected for 10 hours to a pressure 80 per cent higher than the maximum static value. These exacting tests failed to give evidence of defects in the manhole connections, which was not a part of the equipment supplied by Escher Wyss. Rupture of the pipe is attributed to a chain of unfortunate circumstances, the explanation of which will be the work of a committee of investigation which has been appointed.

U.S.S.R. Plans 79 Power Stations

Electric energy output in the U.S.S.R. is to be raised to 38,000 million kw.-hr. by 1937, the end of the Second Five-Year Plan. The installed capacity of power stations is to reach 10.7 million kw., an increase of about 500 per cent in capacity during five years. This increase will be obtained through the construction of 79 regional, and scores of factory and municipal power stations. Particular attention is to be paid to the combined output of energy, steam and hot water, and the power and number of central electric heating stations is to be substantially increased.

A high-voltage line is to connect Donetz Basin with Dniepropetrovsk. This will create an energy system of about 9,000 million kw.-hr. annually. The Moscow system will bring its installed capacity up to 1,200,000 kw. with a number of central electric heating stations. Plans to develop regional stations in Middle Asia, where no stations were built during the First Five-Year Plan, are receiving attention.

Rion Power Station, U.S.S.R., has added a third section of 17,500 hp. The fourth section will be completed by March instead of September, as originally planned.

Natural Gas Engineering Laboratory

In cooperation with the Natural Gas Men's Ass'n of Penna., the School of Mines, University of Pittsburgh, Pittsburgh, Pa., has arranged for the establishment of the first engineering laboratory in the new Cathedral of Learning. Schenley Park, to be devoted to instruction and research in natural gas engineering. A complete 4-year curriculum is being outlined with courses to begin next fall. Prof. H. C. George, head of the Oil and Gas Department at the institution, will be in charge.

Georges Claude to Build Refrigeration Plant on Ship

As a sequel to his partially successful attempts to harness the sea in Cuban waters by the development of electrical energy from low-pressure steam turbines operated by sea water of different temperatures, Georges Claude, eminent French scientist and inventor, hopes to begin practical experiments again in the ocean off Brazil. After several weeks of taking ocean temperatures, he plans to bring to the Brazilian coast a 10,000-ton laboratory ship now being remodeled and fitted to use as an ocean power plant to manufacture ice.

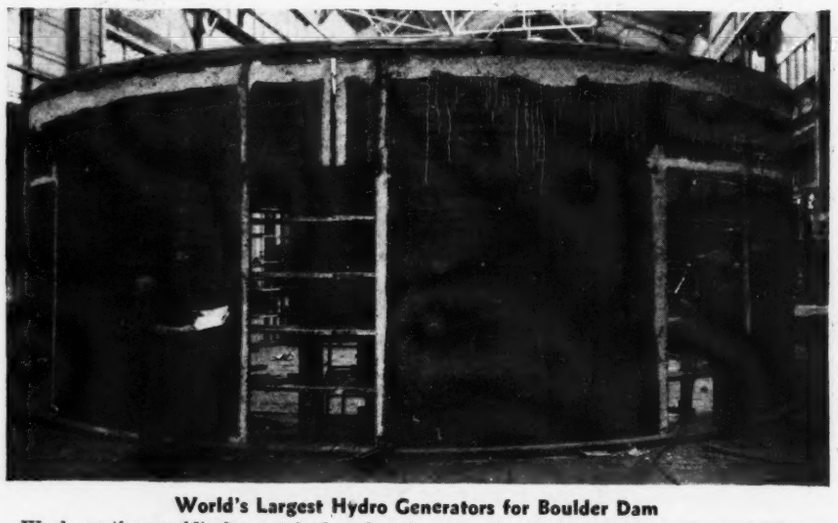
The ship will carry a tube more than 2,100 ft. long and about 7½ ft. in diameter, which will be suspended vertically in the sea and through which cold water will rise to condense the exhaust of the low-pressure turbines.

Coal Papers in Program

Included in the papers at the 143rd meeting of the American Institute of Mining & Metallurgical Engineers at the Engineering Societies Bldg., New York, Feb. 19-22, were several of general interest to power engineers. One was "Classification of Coals of the United States According to Fixed Carbon and B.t.u.," by W. A. Selvig, W. H. Ode and A. C. Fieldner. This has been published as technical publication No. 527 of the Institute and follows out the tentative scheme proposed in October, 1932.

Another paper of particular interest is "Anthracites and Semianthracites of Pennsylvania," by Homer G. Turner. The author lists, in the anthracite group, three classes, according to dry fixed carbon; meta-anthracite, 98 plus, anthracite 92-98, and semianthracite 86-92 (non-agglutination).

The Technical Bureau, 80 E. 11th St., New York, N. Y., an organization of over 500 American engineers engaged in consulting work exclusively on behalf of Soviet industries, wishes to receive trade literature from American manufacturers of power equipment and accessories. This literature will be forwarded to Russian industries interested in the different products. The Technical Bureau has received many requests from Soviet technical libraries and engineering clubs for this literature to be placed on their shelves for general reference.



World's Largest Hydro Generators for Boulder Dam

Work on the world's largest hydro-electric generators, being built by General Electric for installation at Boulder Dam, is in progress. The stator frame for one of the 82,500-kva. units, which will weigh more than 2,000,000 lb. apiece, is shown being assembled at Schenectady

POWER NOTES

Dan Creedon, formerly chief engineer of the McAlpin Hotel, New York, N. Y., has become, as of Feb. 15, chief engineer and superintendent of buildings for R. H. Macy & Co., New York's largest department store. He succeeds Thomas Brennan, engineer for the past 47 years, who died Nov. 15. Mr. Creedon, a member of Stevenson Association No. 44, N.A. P.E., is an ardent believer in private power generation and has been with the McAlpin for the past eleven years, beginning there under W. W. Downey and becoming safety engineer several years ago. He succeeded Mr. Downey when the latter became director of engineering for the Cornell Medical Institute. The Macy plant, largest private plant in the city, comprises a 250-kw., four 400-kw. and two 750-kw. steam-engine driven d.c. generators, a 1,000-kw. generator driven by a low-pressure steam turbine and two 800-kw. generators driven by diesel engines, with the additional refrigerating, water heating and associated equipment required for the store. This includes the largest department-store air-conditioning installation in New York, the compressors for which are driven by two 400-hp., low-pressure, steam turbines.

Frank G. Brinig, works manager for the past six months of Erie City Iron Works, Erie, Pa., has been appointed general manager. He has been with the company for more than 30 years, having served in various capacities in manufacturing, engineering and sales.

Chas. H. Bauer has been engaged as merchandising manager of the V-belt Department, Manhattan Rubber Mfg. Div., Passaic, N. J.

Donavon B. Church has been transferred from the San Francisco branch office to the factory engineering department of Mason-Neilan Regulator Co., Boston.

James Cleary, sales executive for many years of Combustion Engineering Co., Inc., has been appointed manager of the Philadelphia sales district and will make his headquarters at the Philadelphia office, 1616 Walnut St. Fred L. Farrell has been appointed manager of New England sales territory, with headquarters in the Chamber of Commerce Building, Boston. G. O. French has been engaged as sales engineer, specializing on sales work in connection with fire-tube boilers and special shop work. Mr. French was previously New York district sales manager of Air Preheater Corp.

Howard Coonley has been re-elected president of the American Standards Association for 1934. Mr. Coonley is president of Walworth Co., New York, and director of several other organizations.

Gardner C. Derry, sales manager of the Power Division, has been elected vice-president of B. F. Sturtevant Co., Boston.

Frank E. Early has been appointed chief engineer of the Foto-Flo Meter Department of the Trimount Instrument Co. Mr. Early was formerly connected with Bailey Meter Co.

Dr. Ralph E. Hall, director, Hall Laboratories, Inc., Pittsburgh, Pa., has been selected as the recipient of the 1933 Pittsburgh award of the Pittsburgh Section, American Chemical Society for his contributions to the fundamental knowledge of boiler-water reactions and their applications to the practical solution of boiler-water problems and his discoveries and accomplishments in the beneficiation of water for industrial and domestic uses. This is the first award of this honor.

William M. Kauffman, formerly with National Transit Pump & Machine Corp., Oil City, Pa., has become development engineer of the Gas and Diesel Engine Division of Worthington Pump & Machinery Corp., Buffalo, N. Y.

Stuart C. Lawson has been appointed manager of Evans Equalizer Co., New York, N. Y., succeeding W. P. Frost, resigned. Mr. Lawson, in addition to sales, will have charge of engineering and development work.

Gordon Fox has been elected vice-president of Freyn Engineering Co., steel-mill consulting engineers of Chicago. Since 1920, Mr. Fox has been power and electrical engineer of this company. The past five years he spent in the U.S.S.R., where Freyn Engineering, in association with the Russian organization, Gipromez, has cooperated in the development of the steel industry of the Soviet Union. Between 1914 and 1920 Mr. Fox was electrical engineer of Steel & Tube Co. of America and its predecessor, Mark Mfg. Co. After his graduation from the University of Wisconsin in 1908, Mr. Fox was associated with General Electric Co. in several capacities until 1914. He is the author of many articles in the technical press.

David McBride, chief engineer of the plant of S. A. Woods Machine Co., South Boston, Mass., retired Jan. 31, after 51 years of service with that organization. He received a gold watch presented by Pres. H. C. Dodge on behalf of fellow employees.

C. R. Messinger, chairman of the board, Chain Belt Co., Milwaukee, Wis., has resumed the post of president, left vacant by the sudden death of his brother, Clifford F. Messinger.

A. G. Pratt, president of Babcock & Wilcox Co., has been elected to the board of directors of Worthington Pump & Machinery Corp.

Riley Stoker Corp. has opened an office on Alameda Blvd., Baltimore, Md. J. F. White is district manager.

Ingersoll-Rand Co. has acquired the turbo-blower business of General Electric Co. and will consolidate it with its own Turbo-Blower Department.

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has moved its Buffalo district office to Liberty Bank Bldg.

D. W. Haering & Co., Inc., Chicago, has enlarged its eastern staff, adding Edwin H. Chandler in Rhode Island and Albert Nickerson, Albert Stewart and C. W. MacKinnon in Mass.

OBITUARIES

Harry H. Atkinson, president of Economy Lubricating Co., Boston, Mass., since its organization in 1909, died recently at Augusta, Ga.

Ward I. Cornell, for the past twenty years associated with the Boston office of the Hartford Steam Boiler Inspection & Insurance Co., died at the Newton Hospital Feb. 7.

Harry T. Edgar, for 32 years a leading operating executive in the Stone & Webster organization and widely known in the power field, died at his home in Sherborn, Mass., Feb. 15, after an illness of a week. He was an Edison pioneer, and had managed power companies in the West, South and Middle West, besides having served as district manager of Stone & Webster properties in the Michigan, Iowa and Kentucky area for 17 years. He retired in 1931 and was a brother of the late Charles L. Edgar, for many years president of Boston Edison Co.

George E. Fisher, 61, fire protection engineer for Arkwright Mutual Fire Insurance Co., Boston, and widely known in electrical and power circles in eastern Massachusetts, died suddenly Feb. 5. He had been with Arkwright since 1909.

Frank W. Kennedy, 58, vice-president and general manager of De Laval Steam Turbine Co., Trenton, N. J., died at his home at Yardley, Pa., Jan. 24, after a short illness. He became general manager of De Laval Steam Turbine Co. at Trenton, in 1908 and in 1916 was elected vice-president. Mr. Kennedy was also president and director of American Bauer-Wach Corp., New York.

Chas. J. Snow, 66, treasurer of Bruce-MacBeth Engine Co., Cleveland, Ohio, died Jan. 22, after being ill for over a year.

STRAWS

Pointing the way the business wind blows

Central Nebraska Public Power & Irrigation Ass'n, Hastings, Neb., D. W. Kingsley, president, has negotiations under way for a Federal loan and grant for $44,054,742, for a proposed hydro-electric power and irrigation project on the North Platte River, to provide power and water facilities in portions of Kearney, Phelps and Adams Counties. Dam site selected near Holdrege, Neb. Four large water-storage reservoirs will be built in addition to a series of water canals, electric-operated pumping plants and other irrigation works. Clark E. Mickey, Hastings, is consulting engineer.

Kanawha Valley Power Co., Charleston, W. Va., has secured permission from the Federal Power Commission to construct and operate two hydro-electric generating plants at the New London and Marmet dams and locks on the upper Kanawha River, now being built by the Government and scheduled for completion in the spring. The two hydro-electric plants are estimated to cost over $2,000,000.

Great Northern Distilleries, Inc., Fostoria, Ohio, Don T. Hanover, president, plans new 1-story power house at proposed multi-unit distillery near plant of the Farmers' National Grain Elevator Co. To be started at early date, with estimated cost of $400,000. H. W. Hannah, 118 Mass. Ave., Detroit, Mich., architect.

Summit Light & Power Co., Summit, Miss., recently organized by J. W. Garner, R. H. Felder and associates, is planning construction of steam-operated electric light and power plant for local light and power service. Initial station is estimated to cost over $75,000, with equipment.

Clinton Cotton Mills and Lydia Cotton Mills, Clinton, S. C., affiliated organizations, have just completed a turbine-generating plant for power supply at both mills. The new station has a rate capacity of about 8,000 hp. and represents an investment of close to $250,000. It will replace service facilities heretofore secured from Duke Power Co.

Newark, N. J., has made application for a Federal loan and grant of $30,000,000 for a proposed municipal electric light and power plant, to be constructed and operated by the Department of Parks & Public Property. Project now tentative.

Board of District Commissioners, District Bldg., Washington, D. C., is asking bids until March 15 for one motor-driven centrifugal pumping unit of 5,000,000 gal. per day capacity, with complete accessory equipment, for Anacostia pumping station.

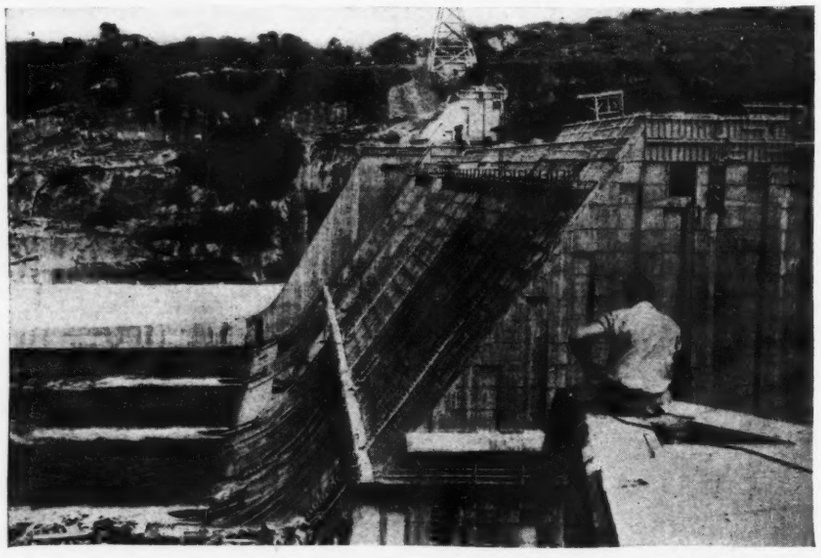
Department of Public Utilities, City Hall, Cleveland, Ohio, has plans for a new power station and mechanical blower plant at sewage disposal works in Eastern part of city, and will proceed with project at early date. It is estimated to cost about $300,000. Bids will be asked by the Commissioner of Purchases & Suplies, City Hall. George B. Gascoigne & Co., Leader Bldg., consulting engineers. Plans are also being arranged by the Department for extensions and improvements in municipal electric light and power plant at East Fifty-third St. and Lake front, to include installation of new equipment. Project is estimated to cost about $250,000 and is scheduled to begin in the spring. William J. Rogers, director.

Washington, Kan., is having plans completed for a new municipal electric light and power plant, estimated to cost about $88,000, with equipment. A Federal grant and loan in that sum is being arranged. Proposed station will be of diesel engine-generator type. Bids scheduled to be asked at early date. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

American Gas Construction Co., Rand Tower Bldg., Minneapolis, Minn., is projecting plans for a large pipe line project to furnish natural gas at Minneapolis and vicinity. It is proposed to construct a welded steel pipe line from gas fields in Montana, with series of compressor stations and terminal facilities, including storage and distribution plant, meter houses and branch distributing lines. The complete program will cost upward of $12,000,000. Surveys will be placed under way early in the spring. Charles I. Tenny, president.

Winthrop, Minn., has plans under way for a new municipal electric light and power plant, for which equipment bids will be asked early in the spring. A fund of about $75,000 is being arranged for the project. Ralph W. Richardson, New York Life Bldg., St. Paul, Minn., consulting engineer.

Several Missouri municipalities have plans maturing for municipal electric light and power stations. Moberly has called a special election March 20 to approve bonds for $700,000 for extensions and improvements in present power plant, including two 2,000-kw. turbo-generator units and accessories; Russell & Axon, 4903 Delmar Blvd., St. Louis, consulting engineers. Perry has secured a Federal loan and grant of $63,590 for a new diesel engine-generating plant. Plans being completed by W. B. Rollins & Co., Railway Exchange Bldg., Kansas City, Mo., consulting engineers. Mount Vernon is arranging a fund of $23,630 through Federal aid for new addition to present municipal station, to include a new diesel engine-generator unit and accessories; Shockley Engineering Co., Graphic Arts Bldg., Kansas City, Mo., consulting engineer. Monroe City proposes extensions and improvements in municipal electric light and power plant to cost $60,000, including installation of additional equipment, and is arranging fund of that amount through Federal aid; W. B. Rollins & Co., noted above, also consulting engineers for this program. Farmington is having plans completed by Arthur L. Mullergren, Fairfax Bldg., Kansas City, Mo., consulting engineer, for a new diesel engine-generating plant to cost about $120,000, with equipment, and is securing Federal loan and grant in that amount, work being scheduled to begin as soon as financing is completed. Fredericktown has plans for a municipal electric power plant to cost $132,525, including equipment, and is concluding financing for the project; Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.



Globe-Topical Press

POWER FOR THE PANAMA CANAL

Madden Dam, being constructed on the Chagres River near Alhajuela, Panama Canal Zone, will form a 620,000 acre-foot storage reservoir to increase the water supply for operating the Panama Canal. Two of three 11,200-hp. units to be operated under 125-ft. head are to be the initial installation in the power house to be built at the dam

Provincial Paper Co., Port Arthur, Ont., has made a change in its methods of producing steam for use in its mill processes. Instead of coal, electricity will be used, the power coming from the Nipigon River development of Ontario Hydro. It will make the steam in two electric boilers of 12,000 kw. each, equal to about 16,000 electrical horsepower. Heretofore some 30,000 tons of soft coal had been used for the purpose.

Yarnall-Waring Co., Philadelphia, Pa., feels that a faster business pace is starting, indicated by two rush orders which they have just received, one, for eight 2½-in. suction valves from Highland Park Power Station, Charlotte, N. C., and the other a telephone order for eight 1½-in. and two 2-in. suction valves from Container Corp. of America, Philadelphia. In December, this company ordered twelve 1½-in. and three 2-in. valves.

D. W. Haering & Co., Inc., Chicago, reports an increase in sales for 1933 of 111 per cent over 1932. The gain in sales was well distributed throughout the year.

The 1933 business record of Minneapolis-Honeywell Regulator Co., Minneapolis, showed an increase in excess of 23 per cent over 1932. The company is looking forward to a greatly increased volume of sales in 1934.

Probably the largest order ever placed for sectional plate pipe is that for 2,460 lineal feet of Toncan pipe, 10 ft. in diameter, for use in Lake Okeechobee flood control project in Florida. C. Y. Thompson, of Greenwood, S. C., is general contractor, the project being under the direction of the U. S. Army Engineers. The contract was placed with the Tri-State Culvert Manufacturing Co., Memphis, Tenn., and will be assembled from No. 5-gage galvanized plates with 6-in. corrugations, which will receive asphalt coating in the field.

Knoxville, Tenn., is presenting a formal application for a $3,225,000 Federal loan and grant to finance municipal power distributing system served by Muscle Shoals power service.

An allotment of $800,000 has been made to the Office of the National Parks, Buildings, and Reservations to add another floor of 108 air-conditioned offices to the Interior Department Building, Washington, D. C. Ten new elevators will also be installed.

Marion, Smyth County, Va., has applied to local PWA officials for a loan and grant of $221,000 to construct a municipal steam-electric plant. Appalachian Electric Power Co. supplies power at present. Marion is the sixth Virginia town to apply for PWA funds for a municipal power plant.

Grand Haven, Mich. has just placed a contract for an 1,100-hp. De La Vergne unit for its municipal plant, which now has two diesels of the same make.

Richmond, Va., is planning a $5,000,000 bond issue to build its own municipal power plant.

Royal Plating & Polishing Co., Newark, N. J., has ordered a Venn Severin diesel through Rudolf O. Liefke.

Crewe, Hottoway County, Va., has applied to the PWA for a loan and grant of $126,000 for a municipal power plant.

Riverside & Dan River Cotton Mills, Danville, Va., have begun using power from Appalachian Electric Power Co., to lessen demand on the mill steam plant, now running at an overload. Directors opposed a large outlay to increase plant capacity.

Akron, Ohio, is planning immediate action to acquire a municipally owned power plant. This action is due to the Ohio Edison Co.'s refusal to grant a reduction in rates.

A State authority to supervise the development of the Santee-Cooper rivers power project, at a proposed cost of about $34,000,000, has been recommended in preference to Federal or private interests. Columbia Railway & Navigation Co. had applied for a loan for the development.

Luray, Va., will probably make a renewal contract with Page Power Co. The company's franchise expires in July. Meetings have been held during the past two weeks between the town council's committee and the power company in an effort to reach a satisfactory compromise.

Rockville Center, N. Y., is considering the plan to obtain a loan from the P.W.A. to purchase another 2,000-kw. diesel-generating set, to meet expected load increases.

John Royle & Sons, Paterson, N. J., have ordered a 150-hp. high-speed McIntosh & Seymour diesel for plant power.

Steel & Tubes, Inc., subsidiary of Republic Steel, is receiving bids for an 80x400-ft. addition to its plant on E. 131st St., Cleveland, Ohio. It will be used to expand facilities for production of electrically welded steel boiler tubing and mechanical tubing. Business is 200 per cent ahead of last year. Cost of the extension is estimated at $250,000.

Mt. Vernon (Ill.) Furnace & Mfg. Co. has ordered a 150-hp., 400-r.p.m. diesel from Worthington Pump & Machinery Corp.

FEDERAL ALLOTMENTS

To	For	Loan and/or Grant	Total, Thousand Dollars
Power Plants, etc.			
Burlington, Vt.	Two 310-hp., one 650-hp. diesel-gen., etc.	G	74
Buhl, Minn.	Power & light pl. imp.	L & G	34
McPherson, Kan.	3,000-kva. turbo-gen., etc.	L & G	211
Cheyenne Indian Agency, S. D.	Elec. gen. unit	G	25
Mescalero Indian Agency, N. M.	Elec. gen. unit	G	25
Brownsville, Tex.	Repair power plant	L & G	200
Kennett, Mo.	Three 220-kw. diesel gen.	L & G	150
Wash. State Coll., Pullman	Pr. & heating plant, etc.	G	198
Mass. State Coll., Amherst	625-kva. st. turb. gen., etc.	L & G	121
State Tchrs. Coll., Fredericksburg, Va.	Inc. boilers	L & G	360
Fairfax Co., Va.	Inc. heating pl.	G	43
Dinwiddie Co., Va.	Inc. heating pl., well & pumps	G	3.8
Sanborn, Minn.	Repair heating & vent. system	G	2
Carrolton, Ky.	Heating plant	L & G	12
School for Blind, Vinton, Ia.	Inc. boiler & stoker	G	29.7
Albany (N. Y.) Boys Acad.	Inc. heating	G	25.2
Hydro-Electric			
Nowata, Okla.	Dam & pumps	L & G	21
Refrigeration Plant			
Bridgewater State Farm, Mass.	Central refrig. pl.	L & G	19
Waterworks & Pumps			
Ridge Farm, Ill.	Well and pumps	L & G	53
Eminence, Ky.	Waterworks	L & G	90
Vienna, Ill.	Well and pumps	L & G	60
Olive Hill, Ky.	Filtration	L & G	26
Henceville, Ala.	Waterworks	L & G	20
Wellington, Colo.	Wells and pumps	L & G	5
Rembrandt, Ia.	Waterworks	L & G	13
Mt. Sterling, Ill.	Dam and filter pl.	L & G	80
Junction City, Ky.	Waterworks	L & G	52
Belpre, Ohio	Waterworks	L & G	72
Springville, Ala.	Waterworks	L & G	36
Martin, Ky.	Waterworks	L & G	43
Weimar, Tex.	Waterworks imp.	L & G	10
North Haven, Me.	Waterworks imp.	L & G	6
Spickardsville, Mo.	Deepwell, pump	L & G	11
Reading, Pa.	Waterworks imp.	L & G	1,195
Cleveland, Okla.	Waterworks imp.	L & G	200
Humble, Tex.	Waterworks	L & G	60
Humble, Tex.	Sewer and pumps	L & G	50
Wells, N. Y.	Waterworks	L & G	65
Hallettsville, Tex.	Waterworks imp.	L & G	29
Penn Yan, N. Y.	Sewage disp.	L & G	48
Leonard, Tex.	Waterworks imp.	L & G	5
University Park, Tex.	Waterworks imp	L & G	121
Columbus, Wis.	Sewage disp.	L & G	17
Wisconsin Dells, Wis.	Waterworks, imp.	L & G	12
Menomonee Falls, Wis.	Sewage disp.	L & G	21
Gallatin, Tenn.	Waterworks imp.	L & G	30
Richmond, Tex.	Waterworks	L & G	58
Ramsey, Ill.	Waterworks	L & G	34
Brownsville, Tex.	Repair waterworks	L & G	200
Stamford, Tex.	Waterworks imp	L & G	155
Cavalier, N. D.	Waterworks	L & G	60
Port Hope, Mich.	Waterworks	L & G	25
Montrose, Colo.	Filtration pl	L & G	40
Elizabeth, W. Va.	Waterworks	L & G	70
Phoenix, N. Y.	Water meters	L & G	7
Interlaken, N. Y.	Waterworks	L & G	60
Matador, Tex.	Well, pumps	L & G	8
Pasadena, Tex.	Waterworks imp.	L & G	38
Taylor, Tex.	Waterworks imp.	L & G	22
Lebanon, Mo.	Sewer system	L & G	124
Monett, Mo.	Sewage disp.	L & G	50
Santa Rosa, Tex.	Waterworks	L & G	26
Chelmsford, Mass.	Waterworks	L & G	75
McLean Co., Ill.	Sewers	L & G	133

NEW BULLETINS

Air Preheater—Air Preheater Corp., 60 East 42nd St., New York, N. Y. Bulletin No. 933 illustrates applications of Ljungström air preheater in public-utility and industrial steam power plants, and also in industrial heat recovery.

Alloys—Riverside Metal Co., Riverside, N. J. Four new booklets—4-page "Free-Cutting Phosphor Bronze and Nickel Silver," 31-page "Nickel Silver," 31-page "Phosphor Bronze," 14-page "Beryllium Copper," all describing sheets, wire, rods, strips and circles of these alloys.

Diesel Engines—Caterpillar Tractor Co., Peoria, Ill. 44-page catalog illustrating and describing Model "35" diesel tractor, with 5¼x8-in., 3-cyl., 850-r.p.m., 46-hp. engine which will shortly be brought out for stationary and portable service.

Diesel Engines — Werkspoor, N. V., Amsterdam, Holland. Prospectus 42, dated Dec., 1933, describes this company's line of compressorless diesel engines.

Electric Control—Allen-Bradley Co., Milwaukee, Wis. 4-page folder on Bulletin 709 starting switch, a solenoid-operated type.

Flexible Couplings—Poole Foundry & Machine Co., Woodberry, Baltimore, Md. 72-page Catalog 34 shows typical installations, types of couplings, data and general specifications.

Friction Material — Johns-Manville, 22 East 40th St., New York, N. Y. 6-page folder, "Industrial Friction Materials—Types and Their Selection."

Ball Bearings and Power-Transmission Units—Fafnir Bearing Co., New Britain, Conn. Condensed catalog No. 17 combines information on industrial uses of radial ball bearings and the Fafnir power-transmission line of wide inner ring and ball bearings. Dimensions, interchangeability tables, etc.

Brewery Equipment—Carbondale Machine Co., Carbondale, Pa. 4-page "CO_2 Gas-Storage System," discusses collecting and storing CO_2 under pressure. 4-page "Carbon-Dioxide (CO_2) Regeneration Plant" pertains to new system of liquefying CO_2 gas after it is reclaimed from fermenters.

Power-plant Equipment — Dominion Engrg. Co., Ltd., Montreal, Que., Canada. Vol. 1, No. 1, of "The Dominion Engineer," a monthly free-circulation paper to include articles relating to mechanical equipment, engineering trends and advertising material.

Lubricated Plug Valves—American Car & Foundry Co., 30 Church St., New York, N. Y. 8-page circular No. 51 describes A.C.F. improved lubricated plug valves.

Metallic Packing — American Metallic Packing Co., Pittsburgh, Pa. 36-page catalog on packings for steam, air, gas, gaseous ammonia and CO_2 equipment, including high-pressure types up to 1,200 lb.

Motors—The Louis Allis Co., Milwaukee, Wis. New bulletins include 4-page 508-C "Explosion-Proof Motors," 6-page 512-B on "Splash-Proof Motors," 6-page 507-A, "Direct-Current Motors," 4-page 514 on "Self-Contained Capacitor Single-Phase Motors," 8-page 505-C on "Squirrel-Cage Motors," 8-page 504-A on Type H "Wound-Rotor Motors," and 16-page 500-A on "Multi-Speed Squirrel-Cage A. C. Motors."

Molded Gears—Poole Foundry & Machine Co., Woodberry, Baltimore, Md. 302-page catalog listing approximately 10,000 different sizes, kinds and types of machine-molded gears ranging in size from 3 in. to 15 ft. in diameter, and weighing from 5 to 70,000 lb.

V-Belts—Gates Rubber Co., Industrial Division, 999 S. Broadway, Denver, Colo. Catalog Sheet 3853 gives numbers, sizes, list price and net weights of Gates Vulco-Rope Drive, and a table of interchangeable belt sizes.

Roller Bearings—Timken Roller Bearings Co., Canton, Ohio. 258-page engineering journal, including descriptions of various types of bearings and technical data on ratings, load calculations, bearing selection, and information on mounting use and maintenance.

Stainless Steel—Republic Steel Corp., Republic Bldg., Youngstown, Ohio. 14-page "Enduro Stainless Steel" gives data on fabrication properties, shapes and finishes available; also distributors. Bulletin 124.

Valves—Edward Valve & Mfg. Co., East Chicago, Ind. 8-page folder "Portrait Gallery of Some New Edward Valves."

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Fallbrook—Fallbrook Irrigation Dist., Dr. B. C. Edwards, pres., made application to P.W.A. for loan and grant to finance construction of dam and water distribution system at Temecula Canyon on Santa Marguerita River. Dam to be rock and semi-hydraulic fill construction, 210 ft. high, 700 ft. crest length, 230 ft. base length, 1,689 acre ft. capacity, 514,500 cu.yd. earth excav., 414,656 cu.yd. rock fill, pumping plants, distribution reservoirs, pipe lines, gate valves and fittings. $2,360,000.

Calif., Riverside—Supervs. Riverside Co., Court House, have authorized W. L. Carlson, purch. agt., to procure estimates of cost of installing Delco or Diesel system to generate power to serve county hospitals.

Ga., Augusta — City allotted $1,250,000 by P.W.A., to finance construction power plant, contingent upon successful execution of contract between Georgia Power Co. and City of Augusta, for standby power. Negotiations on this contract are to be undertaken in very near future, and whether or not the project actually becomes a reality depends largely on the negotiations. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ill., Aurora—City plans waterworks improvements, incl. distribution system, 1½ m.g. tank on steel tower, 4 m.g. concrete reservoir, pumping equipment. $50,000. Applied for loan under P.W.A.

Ill., North Chicago—City, M. O'Peka, clk., City Hall, made plans power plant. $425,000. Applied for loan under P.W.A. Neiler, Rich & Co., 431 South Dearborn St., Chicago, engrs.

Ill., Waukegon—Election Apr. 17, $500,000, municipal power plant. Engineer not appointed.

Ind., Goshen—City plans nearing completion waterworks, incl. 1 story, stone, steel building, 500,000 gal. steel tank and tower, 2 new deep wells, 2 gas or diesel driven pumps, 3 electric pumps, 4- to 12-in. c.i. pipe. P.W.A. project. C. Brossman, Chamber of Commerce Bldg., Indianapolis, engr.

Ind., Hillsboro—Town Bd. plans electric light plant and lighting system, waterworks and distribution system. $75,000. Applied for loan and grant under P.W.A.

Ind., Morristown—Town, W. Whiteside, clk., votes in favor of electric light plant. $50,000. Will apply for loan under P.W.A.

Ia., Corning—Bids Mar. 12, by City, electric plant, with diesel generating equipment and complete electrical distribution system. $160,000. Young & Stanley, Inc., 211 Iowa Ave., Muscatine, engrs.

Ia., Gowrie—Bids Mar. 19, by Town, municipal electric plant, incl. diesel generating equipment and complete electrical distribution system. $80,000. Young & Stanley, 211 Iowa Ave., Muscatine, engrs.

Ia., Winfield—Bids Mar. 22, by City, municipal electric plant, incl. power plant with diesel generating equipment and complete electrical distribution system. $70,000. Young & Stanley, Inc., 211 Iowa Ave., Muscatine, engrs.

Ky., Mt. Sterling—Cleveland Windsor Co., Mt. Sterling, plans by J. W. Little, archt. and engr., Plymouth Bldg., Cleveland, O., power plant at distillery. $100,000 or more.

Md., Annapolis—Bids Mar. 7, by Bu. Yards & Docks, Navy Dpt., Wash., D. C., 4 watertube boilers with superheaters, boiler settings, oil burners, fuel oil pumping and heating equipment, preheaters, smoke flue, forced draft and induced draft fans, combustion control system, continuous blow-down equipment, soot blowers, valves, gages, and other boiler appurtenances at Naval Academy, Spec. 7574.

Md., Annapolis—Bu. Yards & Docks, Navy Dpt., Wash., D. C., taking bids (Date not set for opening) altering central power plant, removing existing construction and equipment, new floors, partitions, etc., Spec. 7618; 9 panel remote control switchboards with high voltage switch gear, turbo-exciter, drive motor for existing 300 kw. generator at power plant, Spec. 7576; mechanical equipment and piping, incl. surface condensers, feed water heaters, motor and turbine driven pumps, structural supports, oil storage tank, piping and accessories, altering plumbing, ventilating system, Spec. 7575; underground distribution system, transformers, houses, equipment, wires, cables, conduit ducts and altering existing work at U. S. Naval Academy, Spec. 7441.

Mass., Ludlow—Town, Bd. Selectmen, Town Hall plans municipal electric light plant. To exceed $40,000. Engineer not appointed.

Mich., Mackinac Island—Municipality plans electric power plant. E. Carey, Iron River, engr. Est. $150,000.

Mich., Marcellus—Municipality plans electric power plant. $110,000.

Mich., Niles—City filed aplication with State for loan and grant to finance construction improvements to power plant. $325,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Minn., Glenwood—Municipality plans electric power plant. Burlingame & Hitchcock, Minneapolis, engrs. $150,000.

Mo., Bloomfield—City, R. H. Dunn, mayor, plans municipal light and power plant and distribution system. $15,900 grant and $56,200 loan applied for under P.W.A. Conzelman & Co., Title Guaranty Bldg., St. Louis, engrs.

Mo., Kennett—City, P. Jones, mayor, plans power plant building, incl. diesel engine, generators, switchboard, distribution system. $150,000 grant and loan allotted by P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, engrs.

Mo., Liberal — City, W. V. Braden, mayor, plans municipal light power plant. Applied for $9,429 grant and $22,000 loan under P.W.A. J. Horn, Cardin, Okla., in charge of plans.

Mo., Moberly—City, election Mar. 20, $700,000, bond issue altering and constructing power plant additions and installing two 236 hp. boilers, two 2,000 kw. turbo-generators, and electric distribution system, Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs.

Mo., Seymour—City, E. B. Mayfield, mayor, plans municipal light and power plant and distribution system. $45,000. Applied for $12,000 grant and $33,000 loan from P.W.A. M. B. Messler, 918 South Bway., Springfield, engr.

Neb., McCook—City defeated $250,000 bonds to finance a P.W.A. loan of $250,000 and grant of $90,000, constructing light and power plant and distribution facilities.

N. J., Lakeland—Bd. Freeholders Camden Co., Court House, plans by Green & MacNelly, Inc., Camden, power plant, at County Hospital. $335,000. H. B. Hackett, Architects Bldg., Phila., Pa., engr.

N. Y., Farmingdale — Village Bd. plans increasing facilities of water plant, incl. sinking new well, installing automatic electric pump to replace present steam pump. $10,000. Applied for loan under P.W.A. to finance 30% of project.

N. Y., Pulaski—Village plans developing and inclosing of springs on Stewart property, 12 in. pipe line from springs to village mains, 2 new centrifugal pumps. $60,000. Will hold election soon to vote on bonds for same. J. P. Wells, Rochester, engr.

N. Y., Seneca Falls—Village plans municipal light and power plant. $89,000. H. T. Sherman, c/o McIntosh, Seymour Corp., Auburn, N. Y., engr.

N. D., Devil's Lake—City plans power plant, $300,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs. Application for loan and grant approved by State.

O., Cleveland — City, W. J. Rogers, dir. P. Utilities, soon takes bids resetting 6 boilers, replacing ash hoppers under four boilers and repair machinery and equipment, at light plant, East 53rd St. and Lake Ave. $250,000. L. A. Quayle, City Hall, engr.

Pa., Phila. — Phila. Wholesale Produce Market, Inc., plans by G. M. Simon, 1500 Walnut St., commission terminal facilities, incl. 15 story office building, cold storage facilities, stalls, freight sidings, etc., Oregan Ave. near Delaware Ave. $3,300,000 P.W.A. project.

Utah, Parowan—City plans improving municipal hydro-electric plant. $75,000. A. Fife, Cedar City, engr. Applied for loan under P.W.A.

Va., Crewe—Town plans electric power plant. Applied for $126,000 loan and grant under P.W.A.

Va., Roanoke — Appalachian Electric Power Co. plans expending $150,000 during 1934 to improve distribution lines, substations and equipment.

Vt., Burlington — Municipality plans electric power plant, incl. diesel engines, generators, etc. $200,000. R. E. Palmer, 7 Montgomery St., Holyoke, Mass., engr.

Ont., Goward—Temogami Timber Co. Ltd., S. H. Burwash, mgr., soon takes bids power house, machine shop and saw mill. $100,000. Will require equipment.

Australia, Mackay — Bids May 1, by Town Clerk, materials and machinery, incl. pumping equipment, accessories, for sewerage scheme. A. E. Harding Frew, Queens St., Brisbane, engr.